Charles University in Prague

Faculty of Social Sciences

Institute of Economic Studies

BACHELOR THESIS

Virtual Gold Farming

Academic Year 2011/2012

Author Filip Šmolík

Declaration of Authorship

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Prague, 30. července 2012

Signature

Acknowledgments

The author is grateful especially to PhDr.Ing Jiří Skuhrovec (for access to World of Wacraft, provision of data and invaluable comments) and my family (for material and moral support).

Bibliografický záznam

Šmolík, Filip. *Virtual Gold Farming.* Praha 2012. 85 s. Bakalářská práce (bc.) Univerzita Karlova, Fakulta sociálních věd, Institut ekonomických studií.
Vedoucí diplomové práce PhDr.Ing. Jiří Skuhrovec

Keywords Gold Farming, Real Money Trade, Virtual Economies, World of Warcraft

Klíčová slova Gold Farming, Real Money Trade, Virtuální Ekonomiky, World of Warcraft

Délka 108 tisíc znaků

Abstract

At the end of 20th century new branch of computer games was developed – MMORPGs (Massive Multi Player Online Role Playing Games). This thesis deals with new phenomenon connected with them – RMT(Real Money Trade), which consists of selling virtual (in-game) currencies for real currencies (mainly US dollar nad euro). Demand side of this business is constituted by players of MMORPGs, supply side consists of so-called gold farmers. Thesis itself is focused on key variable of RMT – exchange rate between real a virtual currency. With help of theoretical model it is demonstrated that the exchange rate affects player's decisions related with RMT. Then it is shown, which variables have impact on exchange rate itself and there is described one of the possible sources of disturbances – operator of MMORPG. Operator's updating policy is analyzed and in empirical part some updates are chosen and it is demonstrated that they affect exchange rate in accordance with previous established theory.

Abstrakt

Na konci 20. století vznikla nová větev počítačových her - MMORPGs (Massive Multi Player Online Role Playing Games). Tato práce se zabývá novým fenoménem, který je s nimi spojen - RMT(Real Money Trade), což je prodej virtuálních (tedy vnitroherních) měn za měny reálné (zejména dolar a euro). Strana poptávky v tomto odvětví je tvořena hráči zmíněných her, strana nabídky se skládá z tzv. gold farmerů. Práce samotná se zabývá klíčovou proměnnou, která ovlivňuje RMT – směnným kurzem mezi reálnou a virtuální měnou. S pomocí teoretického modelu je demonstrováno, že tento směnný kurz ovlivňuje hráčova rozhodnutí související s RMT. Dále je ukázáno, které proměnné ovlivňují směnný kurz. V následující kapitole je popsán jeden z možných zdrojů změn tohoto kurzu – provozovatel hry. Právě jeho politika aktualizování hry je analyzována v poslední kapitole – teoreticky i empiricky - na několika vybraných příkladech. U těchto případů bylo zjištěno, že aktualizace ovlivňují směnný kurzu v souladu s teorií.

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Preface

Before we start to analyze the issues, which we described in abstract, we have to mention (and maybe apologize for) two problems connected with the study of this branch of economics. If we compare it with other branches, we realize that it's relatively young discipline, where only small amount of academical papers was published. Works written by Castronova (2002 and 2005), Lehdonvirta (2005 and 2009), Lehdonvirta & Ernkvist (2011) and especially Heeks (2008 and 2010) contain large amount of valuable informations about virtual economies and related issues, but they don't employ rigorous economic methods. Only such paper (which we found) was written by Skuhrovec (2009).

Previous paragraph implies that researcher, who wants to study virtual economies, suffers from lack of academical literature. Hence we have to employ non-academical sources of knowledge, in this case sources from various webpages, which are dedicated to playing online games.

Second problem is that there is large amount of special terms, which are related to MMORPGs. We don't want to confuse reader with them, thus we try to minimize their amount in the thesis itself. For better orientation small glossary of MMORPG's terms is presented in Appendix.

In this thesis we state examples (and empirical study in chapter 5) from MMORPG World of Warcraft, because it is the most popular game of this genre.

Chapter 1

Introduction

This thesis is dedicated to analysis of relatively new form of a market, which was created at the end of 20th century. This business was very specific - objects of its interest were items, which de facto didn't physically exist in real world. Its popularity rose and gradually this market became economic phenomenon as well as social phenomenon. In the thesis we will examine particular components of the market - supply side, demand side as well as attitude of other interest groups involved in it and focus on one important variable, which affects them all.

First chapter is introductory chapter. Its aim is to explain some terms, which will be used later and introduce our reader into issues of virtual economies. We will describe Massive Multiplayer Online Role Playing Games (acronym MMORPGs will be used), virtual worlds, virtual economies as well as Real Money Trade (RMT), gold farming and other terms important for the thesis.

1.1 MMORPGs and their worlds

MMORPGs

MMORPGs are branch of computer games, which enables players to meet each other in virtual space and communicate in real time. MMORPGs allow player to create a character, which represents him. This character explores virtual world, kills monsters and obtains vir-

tual items. All MMORPGs are provided by operators [1]. MMORPGs are a phenomenon of the last two decades. They capitalized on fast spread of Internet, which brought new possibilities to game developers. The most important one of them was possibility of interaction between people in real time within one game. It led to genesis of online playing. MMORPGs represented its more sophisticated branch. The result was that they became popular. The rapid development MMORPG genre underwent in the second half of the 90ths. At this time, important and influential titles in this genre were published - the first generation of MMORPG's. Among them were for example *Lineage, Nexus, Meridian 59*, and especially the "Big Three" - *Ultima Online, Everquest* and *Asheron's Call*. Beginning of 21th century brought further development of the popularity of the whole MMORPG genre. Their supreme position in the computer games market has confirmed the second generation of these games - *Dark Age of Camelot*, *Eve Online*, *Anarchy Online* and others. In 2004 new game was launched by Blizzard Entertainment - *World of Warcraft*. The game quickly became the most popular MMORPG of all time and still remained (Jinman 2007). Currently (first half of 2012) it has got about 10.2 million of the paying players[2] (i.e. players paying monthly fee for having access to the game - currently about $ 15 [3]) plus unknown numbers of players on semi-illegal servers.

Virtual worlds

Previous definition states that every MMORPG contains its own unique virtual space. This space is called virtual world and it´s crucial for the thesis, because the phenomena, which are described in it, take place there. Bell's definition (2008) includes five main properties. The first one is that virtual world is synchronous, in other words activities of the player take place simultaneously in real time – as was already written. Secondly, it has to be persistent. It means that virtual world is in progress even if player is not in the game. Thirdly, there has to be a network of people, whose actions have influence on the world. Fourthly, in virtual world a player is represented by his virtual alter-ego (which is sometimes called Avatar). At last there has to be a storage of data through a computer. The last property is important,

[1] Operator of MMORPG is a company, which provides the game to the players – takes care about functionality, issues additional game's content,...

[2] http://wow.joystiq.com/2012/02/09/world-of-warcraft-subscriber-numbers/

[3] http://us.battle.net/support/en/article/subscription-options

because it allows virtual world to exist on a large-scale (contrary to for example so-called pen and paper games, which meet some of the previous signs, but they are only for small number of the players).

1.2 Virtual economies

Properties of virtual economies

When we defined virtual world, we stated that actions of the players affect the world and other players too. Thus there are conditions for a formation of economic relationship between them and a resulting birth of virtual economy. If we read Samuelson & Nordhaus (2007), we realize that economy has to include production, consumption and scarcity. Hence we are allowed to say that virtual economy is included in virtual world if three phenomena mentioned above take place there.

Production in the context of virtual economy means creating[4] (or **collecting**) virtual items (Lehtiniemi 2008). Players use their virtual ability to create virtual items or kill NPC[5] monsters and loot their items. Then they sell those items to NPC vendors or via various in-game mechanisms directly to other players. The players buy and then use (consume) the items.

Way of using depends on item's characteristics. The term items includes both goods that are quickly consumed (such as potions), as well as durable items (swords, armor, bows, ...). If we mention durable items, we have to add that usually there is a large amount of services, which are related to them (repairing, upgrading,...) and which co-creates in-game economy. In-game items have five main attributes (Blazer 2006). First of them is rivalry - objects are at some time held by one person or small group of people. Second attribute is interconnectivity. It means that possession of an item may be affected by the ownership and use of other items. Third of them is permanence - object remains in the possession of its owner, even when it is not in use. Fourth attribute (and for the thesis the most important as we will write later) is that there exist secondary markets, thus virtual items can be made, traded, bought and sold.

[4] It means that player is able to create the items and then sell it, see Example of virtual economy

[5] **NPC** is an acronym for non-player character, i.e. in-game character controlled by artificial intelligence.

The last one is added value. In other words, owner of a virtual object can appreciate it.

If we look at the previous five properties, we can see that interconnectivity, existence of secondary markets as well as possibility of item's appretiation are related to already mentioned production and consumption. Permanence (third attribute) means that there is no form of uncertainty except cases given by game's rules (unlike from real world, where property can be stolen, when we aren't at home). Finally, first attribute – rivalry – is very closely linked with third phenomena from our definition and concurrently main reason why economists should examine these virtual economies – scarcity, by definition *the limited quantity of a resource, factor of production or output.* [6] Economics assumes that people want to consume more and more and they cannot be completely satisfied. But consumers are restricted by the fact that resources aren't unlimited, thus people have to optimize their consumption. The same can be seen in virtual worlds too. There are the items, which are common and they are cheap. Better items are harder to find and thus more expensive to buy. Carli (2007) gives an example from Ultima Online, where only rare colour of a horse multiplies its price. Player's desire for consumption of those items collides with his budget constraint. Similarly as in the real world this constraint is affected by the player's ability and time spent on the earning money. If we play arbitrary MMORPG, we can see that quality of in-game equipment (weapons, armors, mounts,..) differs from player to player. This is sign of scarcity. Thus all of the three initially mentioned phenomena take place in virtual economies – production, consumption and scarcity.

Example of virtual economy - World of Warcraft

Now we give an example of a virtual world. We chose World of Warcraft, because it is the most popular MMORPGs. [7] We focus on three previously mentioned phenomena. Before we describe this virtual economy, we have to mention that in World of Warcraft players are divided into two opposite parties – the Alliance and the Horde. Generally we can say[8] that these parties are economically separated.

[6] definition from Rutherford D. *Routledge Dictionary of Economics*,3rd ed., Routledge,2005

[7] www.mmochart/Chart7.html

[8] there is one exception, see http://wow.joystiq.com/tag/neutral-auction-house/

Let's begin with production. In World of Warcraft player is allowed to practice craft, which leads to the creation of virtual objects as well as he can obtains unique items through various types of in-game professions. Examples of first type of professions (*production*) are blacksmithing, tailoring, or leatherworking. Second type (*gathering*) includes herbalism, mining or skinning[9]. Another sort of professions includes abilities, which appreciate other items (we can state enchanting of items for example). Player is developing all these skills through their frequent usage. If we recall Lehtiniemi (2008), we realize that collecting items is part of in-game economy too. In World of Warcraft there is a possibility to collect them from killed NPC characters as well as from other sources.

World of Warcraft allows players to trade with NPC merchants [10] as well as between themselves[11]. Main currency, which is involved in in-game transactions, is gold coins, which consist of silver and copper coins[12]. Aside form gold, there are alternative currencies (for example Honor points, [13] Valor points,..), which player can obtain by various in-game activities. They can be used for buying special items, but it isn't possible to sell them to other player. In-game vendors are universial buyers (they buy almost all items in arbitrary amount). Contrary to this fact they are specialized sellers. Lots of vendors provide some services - for example blacksmith repairs damaged items. NPC merchant has got infinite amount of money, so there is no problem for players to sell arbitrary amount of the items[14].

Trade of players with other players (PvP trade) takes the form of either a barter trade exchange (i.e. primitive exchange of items without an intermediary), or a more sophisticated form of using the mechanism of Auction House (AH). When using barter trade player goes to marketplace to meet potential trade partners and with help of ingame communication (public or private chat) tries to sell offered item. The mechanism of the AH is designed for items,

[9] http://www.wowwiki.com/Profession
[10] http://www.wowwiki.com/vendor
[11] http://www.wowwiki.com/Trade_Chat
[12] 1g = 100s = 10 000 c
[13] http://www.wowwiki.com/Honor_point
[14] http:/wowwiki.com/Trade

which are objects of interest of more players. It takes the form of an auction. Players see the price set by seller, start to bid and the object is sold to the player who offered the most (or to the player, who pays so-called buyout price). Existence of these houses implies that players are willing to compete with other players to obtain certain items. If we look at auction prices set by the players, we will see that they are several times higher than price set by game[15]. It means that there has to some form of scarcity, because the players are willing to pay significantly more than the item costs.

Consumption of the items follows what we wrote earlier. There are durable items as well as one-time consumable ones or creatures, which can player use for transport.[16] .

Conclusion

In previous text we described one of many virtual economies. With previous knowledge we can (following Castronova (2005)) state six main reasons, why modern economics should examine these economies

1. **The consumption of virtual goods** - as in the real world, players buy, sell and consume goods.
2. **Improving the skills of virtual character** through time invested into the game. We should be interested in this matter because of the fact that virtual character's skills influence its economic value.
3. **Production of virtual objects by the player.** As we wrote earlier, production is one of the signs of every economy. On the other hands it carries dangers for the stability of the virtual world. In the case of poorly set game system, economic relationship may cause the collapse of the whole world.
4. **Competition between players.** In the virtual world a large number of players are competing for limited resources. All players start with the same (or relatively similar) resources, their further development therefore depends on their abilities.

[15] Based on experiences with collected data from these houses.

[16] http://www.wowwiki.com/Item

5. **Decision making under uncertainty** - the players don't know in advance the consequences of their decisions.

6. **Parallel to the real world** - in the world of online gaming there are economic phenomena that have taken place in the real world too. Related to this the opinion of researchers dealing with this issue (Lehdonvirta, Castronova) is that in the virtual world there are basically the same economic laws as in the real one and those can be used as laboratory for economic experiments.

All of facts mentioned above are good reasons to study virtual economies. But there is one additional (and probably the most important) reason to focus on virtual worlds. On previous pages we implicitly assumed that these economies are closed, in other words independent on other economies, real one included. But already at the end of 20th century new phenomenon became popular – blending of real economy and virtual economy. It meant the origin of RMT.

1.3 RMT and gold farming

RMT

The term RMT abbreviates Real Money Trade, which characterizes its nature well. This activity is about an exchange of virtual assets (the term itself will be explained soon) for real currency (such as USD or EUR). As we wrote above, RMT became popular in the end of the 20th century, although the first sign can be traced before 1990 (Heeks 2008). It is designated for those players, who have got more real money than time, patience or abilities. There are two types of RMT market (Lehtiniemi 2008). The first one - primary market - is provided by operator of the game, who sells virtual assets to the players. Most of online games don't include primary market (Lehtiniemi 2008). On secondary market there are economic relationships solely between the players of these games. We can give a simple example of how secondary RMT works. Consider a virtual world, where there are two players. The first one has got large amount of virtual wealth, whereas second player is poor in the virtual world, but he has got larger amount of real world money. With existence of RMT they can both improve their life. The first of them sells excessive virtual assets and receives real money. The second player sacrifices certain amount of real currency, but improves his virtual character. As we

wrote before, both counterparts improved their positions. But there is another party, which does not have anything from this exchange - operator. Moreover, it can be potentially harmed from it. The reason why will be described in chapter 4. For this moment it's important to note that majority of the operators are against RMT in their products. And they are able to fight it through legal mean.

Each player is bounded by contract with the game's operator - the EULA (End User Licensed Agreement). This agreement restricts the use of player's gaming license. In EULA those operators, who are against RMT, explicitly declare that buying and selling virtual assets for real currency is illegal. This is the main argument of operators - player confirmed his agreement with EULA, thus also with non-participating on RMT. On the other hand, some people were sentenced because of theft of virtual property [17]. It would imply that the players have got rights to capitalize on it. Let's look on example - Blizzard's EULA [18]. There is explicitly written that player is not allowed to:

1. *buy or sell for "real" money or exchange gold, weapons, armor, or any other virtual items that may be used in World of Warcraft outside the World of Warcraft platform;*

2. *let any third person (except for a minor for whom you opened the Account) play on your Account including, but not limited to, using so-called "power levelling services", i.e. paying a third person for playing on your Account; or play on the Account of a third person including, but not limited to, providing so-called "power levelling services";*

Hence in case of World of Warcraft - from legal point of view - player is not allowed to freely dispose with his in-game wealth, nor he can freely manipulate with his account[19].

Now we have to explain the term virtual assets itself. It covers (according Lehdonvirta 2009)

[17] Example from Runescape: http://news.mmosite.com/content/2009-12-01/20091201235706854.shtml

[18] http://eu.blizzard.com/en-gb/company/legal/wow_eula.html, Blizzard is operator of World of Warcraft.

[19] Account in MMORPG (in this case WoW) contains all player's virtual characters and thus all his virtual property. Player pays subscription fee per account, probably most of ordinary players have only one account. On the other hand, there can be as much virtual characters as player wants on the account

virtual items (we wrote about them earlier – durable and non-durable ones), in-game estates, in-game playable characters and last but not least - virtual currency itself[20].

Gold farming

Demand side of RMT consists of players with more real assets than virtual ones (or patience). Now we focus on supply side of the business. It primarily consists of the players, who don't play for joy from the game, but only for purpose of collecting virtual currency and its subsequent trading for real currency.[21] These players are called gold farmers and they often work in larger groups as gold farming company. In chapter 3 we will explain the reasons why as well as we describe this activity more detailed. The activity itself is nothing new - origins are dated back to 1987, when the first transaction of this kind was established. (Heeks 2008). In the 90ths, it mirrored the rise of MMORPGs and 1997 was crucial for it, because the already mentioned Ultima Online was released and RMT concentrated on it (Heeks 2008).

Although the number of gold farmers cannot be accurately calculated[22], the authors specializing in this field agree that the sales volume of gold farmers is permanently increasing (Lehdonvirta & Ernkvist 2011). According Heeks (2008) greater demand for gold farming is closely related with improved access to the Internet and cheaper online games. If we look at gold farming business, we realize that this activity consists of two stages – acquiring virtual assets in the first stage and selling it in the second stage. Price, which consumers (players) pay for obtaining virtual assets, is dependent on the exchange rate between real and virtual money. The exchange rate can be seen on so-called exchange servers – web-pages, where this exchange is negotiated (for example www.wowgoldeur.com, www.bestwowgold.com, www.make-wowgold.com, www.swagvault.com,…).[23] In the thesis we will show that this variable is important for all counterparts.

[20] In next chapters we will use virtual currency rather than virtual asset.

[21] We use wilfully primarily, because in our later analysis we assume that exist players, who are sellers in RMT, but they want to enjoy game too.

[22] it is implied by semi-illegal nature of this activity, no official data are availabe

[23] Problem with our exchange rate is that there are lots of exchange servers and their exchange rates are not same on exchange servers.

Structure of the thesis

In this introductory chapter we described and explained main terms related to the topic of the thesis and we will operate with them in other chapters. The thesis itself will focus on the last of terms stated in previous text – exchange rate between virtual and real currencies.

Chapter 2 will focus on demand side of RMT - the players of MMORPGs. Through the microeconomic model we will show how change in exchange rate affects player's decisions concerned with playing and using RMT.

Chapter 3 is about gold farming companies – supply side of RMT. We will discuss their revenues and costs and show how the exchange rate is affected. In the end hypothesis that operator's actions influence this exchange rate will be stated

Chapter 4 is about struggles between operators and gold farmers. We discuss why operators fight RMT in their games and try to explain why they don't provide it on their own plus we list methods of fighting RMT.

In **chapter 5** we will try to prove that the hypothesis from chapter 3 is correct. It will be done by the tools of econometrics - panel data instruments.

In one sentence – we will show the importance of the exchange rate , explain one of the possible sources of its changes and then we will try to prove this hypothesis correct.

Chapter 2

Players and RMT: motivation and decision-making

Second chapter of the thesis has got two main goals. First of them is that it should describe motivation, which has got players for playing MMORPGs and eventually participating on RMT. Then – before economic analysis itself – paradigm *homo oeconomicus* will be discussed as well as we examine the meaning of utility and consumption in the case of MMORPG player. Last part will be dedicated to decision-making of a player, namely his choice to participate or not to participate on RMT as well as his allocation (time and money) decisions will be discussed. It will be shown that important factor, which affects the decision itself, is the value of exchange rate between real and virtual currency

2.1 Motivation: psychological approach

Before we start to write about motivation, we have to mention one important fact. According to Yee's (2006) study based on his *Daedalus* database it's necessary to abandon prejudices about the players of MMORPGS – that they are only young male students. The opposite fact is true – spectrum of the players was widely diversified, only 25 % of Yee's respondents were teenagers plus there was an increasing amount of female players.

There are lots of studies, which are dedicated to motivation of MMORPG players, for ex-

ample already mentioned Yee (2006), Griffiths, Davies & Chappell (2004), Cole & Griffiths (2007) and Hsu, Wen & Wu (2009). From the oldest study we can mention Bartle (1996). All of these studies have got similar results. They state that main reason why the players spend time in MMORPGs is because of the joy from the game. On the other hand this joy can be reached by various activities. In this thesis we will use Bartle's classification of motivation. Bartle (1996) distinguishes four main types of players. The first of them is the Achiever, whose aim is to achieve the highest number of in-game goals and thus surpass others. These players are natural candidates for the users of RMT because of their need to be the best (or at least better than majority of other players,which naturally results in economic need for high-quality goods, equipment etc.). Explorer is the second type of the player according to Bartle. He wants to explore as much of the game's possibilities and mechanisms as possible. Third type is so-called Killer, whose motivation is fighting and killing other players. It's good to note that in majority of modern MMORPGs there are special areas, where Killers can realize themselves and generally we can say that the possibility of involuntary fighting between players is strongly reduced. The last type is called the Socializer, who is derived from the social aspect of MMORPG. These people stress on social dimension of game – interaction between players, clustering into organized groups of the players (these groups are usually called guilds). In recent studies we can find another type of players, which is not in Bartle's study. It is Role-player (Cole & Griffiths 2007), who identifies himself with his virtual character and play his virtual role – speak and acts in compliance with his in-game characteristics (gender, race, class,…). For the role-playing in all form is typical escape from reality (Bowman 2010).

If we look at the previous types, we can assume that primary candidates on users of RMT are Achievers and then Killers, both because of similar reasons - they have to be better than others.

Another possible view on motivation of the players is through Maslow's hierarchy of needs applied on virtual world. Maslow's pyramid is a concept well-known from psychology. It presumes that human needs have got hierarchical nature and need from higher level cannot

be satisfied until lower level is satisfied [1]. We wrote earlier that some players (especially role-players) project themselves into their virtual characters, thus it is possible to apply the pyramid on virtual world. Now let's focus on particular floors of Maslow's pyramid. We can skip physiological needs (only in special case when virtual character (avatar) has to eat and drink) and then there is the need of safety. If we apply it on MMORPG, then player has got the need to protect his virtual character against excessive dying[2]. Another three levels are the need of socialization, the need of success and the need of self-realization. We can see that the need of becoming apparent is included in human's nature. Link with RMT is fourth and fifth level of Maslow's pyramid, because RMT can help with obtaining additional funds of virtual assets and thus it can bring success and self-realization. This theory implies that in some phase of the game some role-players can use RMT to satisfy their needs.

If we summarize previous section with respect to RMT, we have to write that the most probable users of RMT are Achievers, Killers and Role-players. The first and second mentioned ones because of their competitive nature, the third ones because of their identification with in-game characters.

Economic modeling of player's behavior – homo oeconomicus?

Before we introduce our model, which describes player's behavior, we have to mention one important problem, which is related to this concept. On previous pages we described player's motivation concerned with playing (and potentially with gold farming) and we were able to see the diversity. But now we will use microeconomic tools, which have got very strict assumptions. They assume that analyzed player of MMORPG is *homo oeconomicus*. It means that he is rational – he knows his preferences, searches for information and he arranges all possible alternatives and chooses the best of them. Moreover, he maximizes his utility through consumption - virtual as well as real. It's a question whether this concept isn't in

[1] Maslow, Abraham, *Motivation and personality.* New York: Harper and Row., 2008, applied on MMORPG in bachelor thesis: MMORPG: phenomenon of computer games, M. Pros, MUNI, 2008

[2] It's good to note that in MMORPGs death of virtual character is common, but unpleasant - usually there is some penalty(Runescape - part of player's items is lost, World of Warcraft - in-game character is vulnerable for some time, etc.)

opposition against previous findings. Hence we rather state immediately at the beginning of our analysis that in our model player will use his virtual consumption according to his typology:

1. Achiever - to be better than others.
2. Explorer - to explore virtual world.
3. Socializer - to socialize with other players.
4. Killer - similarly to achiever.
5. Role-player – for maximal identification with his virtual characters.

In the next model we will state that increase of virtual consumption increases player's utility too. Let's state an example. We consider a Killer, which buys better virtual sword, shield and armor. Then he becomes stronger and can kill stronger players. Hence his utility increases.

At last we make a conclusion: our player is a *homo oeconomicus*, because he is (or should be) rational and makes optimization. But there is some joy from playing itself, which is difficult to categorize (as well as the fact that player can be addicted on MMORPG). Hence if we apply *homo oeconomicus* on ordinary player, our results will be weaker. The different case is gold farmer. He plays only for profit, thus homo *oeconomicus* should describe him well.

2.2 Allocation model

Now we will analyze how the exchange rate affects time, which player spends in MMORPG as well as amount of money, which he spends for the purpose of RMT. We will use upgraded model for optimization of consumptions in two periods. Let's assume for simplicity that player is dividing his time only between working and playing. In the first period player works in real world and earns real money. Part of this money consumes and part of them "saves" for

increase of virtual consumption. Let central equation of this model be in following form[3]

$$U = u(W + w \cdot l - s) + f(s \cdot EX + (L - l) \cdot Pr) - v(l)$$

In this model u and f are utility functions for real (respective virtual) consumption ($u^{'}() > 0, u''() < 0$, same for f), W abbreviates initial wealth, l is amount of labor, which is spent with real work, s denotes saving of real money for game's purpose (for the beginning of our analysis we presume that $W + w \cdot l > s > 0$), EX is exchange rate between real and virtual money (for example how much gold player obtains for one dollar) and Pr denotes virtual productivity of player. First term of the equation is utility from real consumption, second one is utility from virtual consumption and third one is harm from working ($v'() > 0, v''() > 0$). This harm is independent on other variables and represents straight disutility from labor. At last, L is the total amount of time, which our player has got available. It is increasing in time, which is spent with labor and convex - harm increases in increasing way. Our goal is to find how l and s (only variables, which can be affected by the player) change with an increase or a decrease of interest rate. It can be made with help of implicit function theorem.[4]

Let $u(*) = u(W + w \cdot l - s)$ and $f(\triangle) = f(s \cdot EX + (L - l) \cdot Pr)$ At first we derive first order conditions (FOCs)

$$\begin{aligned} F &= \frac{\partial U}{\partial s} = -u'(*) + EX \cdot f'(\triangle) = 0 \\ G &= \frac{\partial U}{\partial l} = w \cdot u'(*) - Pr \cdot f'(\triangle) - v'(l) = 0 \end{aligned}$$

We will employ total differential and we will obtain following system of equations

$$\begin{aligned} \frac{\partial F}{\partial W}dW + \frac{\partial F}{\partial s}ds + \frac{\partial F}{\partial l}dl + \frac{\partial F}{\partial w}dw + \frac{\partial F}{\partial EX}dEX + \frac{\partial F}{\partial Pr}dPr &= 0 \\ \frac{\partial G}{\partial W}dW + \frac{\partial G}{\partial s}ds + \frac{\partial G}{\partial l}dl + \frac{\partial G}{\partial w}dw + \frac{\partial G}{\partial EX}dEX + \frac{\partial G}{\partial Pr}dPr &= 0 \end{aligned}$$

[3]Original idea is taken from https://webspace.utexas.edu/sry93/Webpage/ImplicitFunctions.pdf, for the purpose of the thesis original model is significantly changed.

[4]see Appendix

We are not interested in W,w and Pr - let's assume they are fixed, thus $dW = 0$ as well as $dPr = 0$ and $dw = 0$. Now let's divide the equation by dEX and rearrange them. The results are

$$\begin{aligned} \frac{\partial F}{\partial s}\frac{ds}{dEX} + \frac{\partial F}{\partial l}\frac{dl}{dEX} &= -\frac{\partial F}{\partial EX} \\ \frac{\partial G}{\partial s}\frac{ds}{dEX} + \frac{\partial G}{\partial l}\frac{dl}{dEX} &= -\frac{\partial G}{\partial EX} \end{aligned}$$

Now we see system of two equations, which can be solved by Cramer's rule[5].

If we want to know how change of exchange rate affects labor's decision, we have to solve following equation (with help of implicit function theorem and Cramer's rule)

$$\frac{dl}{dEX} = -\frac{\begin{vmatrix} \frac{\partial F}{\partial s} & \frac{\partial F}{\partial EX} \\ \frac{\partial G}{\partial s} & \frac{\partial G}{\partial EX} \end{vmatrix}}{\begin{vmatrix} \frac{\partial F}{\partial s} & \frac{\partial F}{\partial l} \\ \frac{\partial G}{\partial s} & \frac{\partial G}{\partial l} \end{vmatrix}}$$

Nominator is determinant of corresponding matrix as well as denominator. Now we have to compute entire elements.

$$\begin{aligned} \frac{\partial F}{\partial s} &= u''(*) + EX^2 \cdot f''(\triangle) < 0 \\ \frac{\partial F}{\partial EX} &= EX \cdot s \cdot f''(\triangle) + f'(\triangle) ? 0 \\ \frac{\partial F}{\partial l} &= -w \cdot u''(*) - EX \cdot Pr \cdot f''(\triangle) > 0 \\ \frac{\partial G}{\partial s} &= -w \cdot u''(*) - EX \cdot Pr \cdot f''(\triangle) > 0 \\ \frac{\partial G}{\partial EX} &= -Pr \cdot s \cdot f''(\triangle) > 0 \\ \frac{\partial G}{\partial l} &= w^2 \cdot u''(*) + Pr^2 \cdot f''(\triangle) - v''(l) < 0 \end{aligned}$$

[5] see Appendix

We know that 2x2 matrix determinant can be expressed as[6]

$$det \begin{pmatrix} a & b \\ c & d \end{pmatrix} = a \cdot d - b \cdot c$$

Both of our matrixes are 2x2, thus we can write

$$\frac{dl}{dEX} = - \begin{pmatrix} \frac{\partial F}{\partial s} \cdot \frac{\partial G}{\partial EX} - \frac{\partial F}{\partial EX} \frac{\partial G}{\partial s} \\ \frac{\partial F}{\partial s} \cdot \frac{\partial G}{\partial l} - \frac{\partial G}{\partial s} \frac{\partial F}{\partial l} \end{pmatrix}$$

If we look at values of entire elements, which we computed earlier, plus making some numerical operations, we will see that

$$\frac{dl}{dEX} = - \begin{pmatrix} \frac{-Pr \cdot s \cdot u'' \cdot f'' + EX \cdot w \cdot u'' \cdot f'' + w \cdot u'' \cdot f'' + EX \cdot Pr \cdot f' \cdot f''}{det \begin{pmatrix} \frac{\partial F}{\partial s} & \frac{\partial F}{\partial l} \\ \frac{\partial G}{\partial s} & \frac{\partial G}{\partial l} \end{pmatrix}} \end{pmatrix}$$

Neither nominator nor denominator are always higher or lower than zero. On the other hand we are able to use simple fact that we are trying to solve this problem in maximum of the function. Hence according to *second order necessary conditions* theorem[7] we can say that matrix in denominator is negative semidefinite. Now we are able to use *Silvester's theorem*, which implies that determinant of 2x2 symmetric negative semidefinite matrix is higher than zero[8]. Hence our denominator is higher than zero too. But problem with nominator remains. In other words, we are not able to say generally if increase of exchange rate leads to increase or decrease of (L - l). It depends on individual utility function of a player. But we can say that in all cases except from

$$\frac{\partial F}{\partial EX} \cdot \frac{\partial G}{\partial s} = \frac{\partial G}{\partial EX} \frac{\partial F}{\partial s}$$

or in other form

$$EX \cdot w \cdot u'' \cdot f'' + w \cdot u'' \cdot f'' + EX \cdot Pr \cdot f' \cdot f'' = Pr \cdot s \cdot u'' \cdot f''$$

exchange rate between real and virtual currency affects allocation of time in real and virtual worlds. Similar situation is with saving. We are not able to say generally

[6]Hajkova V., Johanis M., John O., Kalenda O., Zeleny M., *Matematika*, Matfyzpress, 2011

[7]Hajkova V., Johanis M., John O., Kalenda O., Zeleny M., *Matematika*, Matfyzpress, 2011, see Appendix

[8]Only condition is symmetry of matrix and $(-1) \cdot \frac{\partial F}{\partial s} > 0$, see Appendix

how the exchange rate affects saving, but we can say that **except one case there is a relationship between them**. We deduced these two results and now we try to generalize them. In the beginning of our analysis we stated that $W + w \cdot l > s > 0$. But this condition determined attitude of our player toward RMT and it is too restrictive. Hence we analyze all possible states of s separately.

1. If $s > 0$, then player is able to save part of his real-world income (and sacrifice his real-world consumption) to boost his virtual consumption, but he is constrained by his real wealth (no possibility of borrowing). Hence he is a passive user (buyer) of RMT and he only buys virtual assets. Let's denote his total utility U^p.

2. If we say that $s = 0$, then player does not use benefits of RMT and thus he is not sensitive on change in exchange rate (special case mentioned above comes to pass). He is a non-user of RMT. Let's denote his total utility U^n.

3. Finally, if $-(L - l) \cdot Pr < EX \cdot s < 0$, then player acts in opposite way and boosts his real consumption instead of virtual one - for every $EX \cdot s$ units of virtual currency which he sacrifices in virtual world he obtains s units of real currency in real world. He is an active user of RMT and similarly to passive user he is constrained by his income, but now by virtual one, which is $(L - l) \cdot Pr$. Let's denote his total utility U^a. In the case of an active RMT user we know that $\frac{\partial F}{\partial EX} = EX \cdot s \cdot f''(\triangle) + f'(\triangle) > 0$ and $\frac{\partial G}{\partial EX} = -Pr \cdot s \cdot f''(\triangle) < 0$. But not even in this case we are able to generally determine effect of exchange rate on labor decision (see $\frac{dl}{dEX}$).

If we use optimization and find optimal s, then we can determine type of the player. Generally, we can say that the total utility of the player is given by the equation

$$U^{total} = max\{U^p, U^n, U^a\}$$

This model is not perfect, because for the purpose of simpler analysis we ignored additional costs, which stem from negative attitude of other players - moral costs (C), which will be discussed later. If we wished to add these costs, we would modify original equation in a following way

$$y = \begin{cases} u(W + w \cdot l - s) + f(s \cdot EX + (1 - l) \cdot Pr) - v(l) & \text{if } s = 0 \\ u(W + w \cdot l - s) + f(s \cdot EX + (1 - l) \cdot Pr) - v(l) - \frac{C}{1-n} & \text{otherwise} \end{cases}$$

In this equation n denotes the share of other players, which are against RMT. New term in second equation is very important. While in a previous model non-users of RMT were reduced to one case from interval $\left(-(L-l)\cdot\frac{Pr}{EX}, W+w\cdot l\right)$, which implies that their amount was reduced close to zero, the term $\frac{C}{1-n}$ causes that majority of MMORPG players doesn't participate on RMT (this fact will be implied by model in chapter 4).

At last there is special type of a player - gold farmer himself. He sells virtual assets for real money - in other words he boosts his real consumption. This attribute is similar to active RMT user, but there is one big difference between these of types of the players - gold farmer's workplace (where ordinary players spend time for labor) is in virtual world. We propose modified previous utility function in following form

$$U^g = u\left(W + \frac{l\cdot Pr}{EX}\right) - v(l)$$

Let's compare gold farmer's utility function with previous ones. Main difference is that gold farmer does not have virtual utility function[9]. His consumption decision is given by his virtual productivity, exchange rate and time, which is spent with gold farming. And there is another difference between gold farmer and other types of the players - gold farmer faces disutility from playing MMORPG ($v(l)$), but he bears no moral cost caused by ordinary player, because he play only for money, not for joy from the game itself. If

$$U^{total} = max\{U^p, U^n, U^a, U^g\} = U^g$$

then our player becomes gold farmer.

At the end of this analysis let's summarize our theoretical results.

1. We found that (except for one situation) the exchange rate affects amount of time, which players spend in the game.
2. Moreover, the exchange rate may affects saving of the players.
3. Neither in the first nor second case are we able to generally show which effect it has got. It depends on individual utility function.

[9]We assume that he consumes only amount of virtual goods necessary to run gold farming

4. Amount of saving (s) determines whether player is a passive user, an active user or a non-user of RMT

5. The exchange rate affects player's decision to become gold farmer.

Beyond C

Now we look what is hidden beyond the variable C. which we denoted as moral costs in previous sections. In this case the term moral cost means that players, who use benefit of real money trade, is put into ostracism of other players, who don't use RMT. Players hate the RMT itself too. First of all according to them, it spoils the game. While without RMT ingame success depends solely on the player's skill and perseverance, in the moment of onset of an exchange between real and virtual world, the players begin to mirror social differences from the outside world (Lehdonvirta 2010) and the game loses one of its main characteristics - escape from reality. Well equipped virtual character becomes a positional good which trumps other players - Lehdonvirta (2005) claims that Veblen effect takes place. This phenomenon, named after the American economist and sociologist Thorstein Veblen, is reflected by the fact that consumers are buying more expensive goods in order to rank themselves with help of their consumption to a certain social group. Applied to the problem of RMT: player is trying to maximize his position in social hierarchy with help of their virtual characters. Therefore he tries to stand out above the rest with character's level, equipment or abilites. If some players fail or they are too slow, they try to use real money to earn this status. Grundy(2008) documents that there is in-game pressure on some players to be successful and they can reach this success only via RMT. From this perspective, it seems that in the whole system of MMORPGs there is a rooted demand for RMT and thus good initial conditions for gold farming. This behaviour, however, causes that players hate RMT users as well as gold farmers.

2.3 Gold farmer's decision

Now we will extend previous model and apply it on developing countries (we will explain later why). Assume a worker, who has got following two options:

1. he can work in virtual sector (gold farming industry). In the previous chapter we

have written that according to Heeks (2008) gold farmers tend to join into companies. Reasons why will be discussed in next chapter. If our worker accepts a job in gold farming company, he earns wage w^v. Let's assume that his productivity is Pr^v.

2. he can work in real sector (the rest), then he earns wage w^r. Let's assume that his productivity is Pr^r.

Assume that his utility function is similar as in the previous model:

$$U^r = u(w^r(Pr^r) \cdot l) - v^r(l)$$

if he works in real industry and

$$U^v = u\left(w^v\left(\frac{Pr^v}{EX}\right) \cdot l\right) - v^v(l)$$

if he works in gold farming industry. At first we assume that initial wealth W is zero, because our worker is poor. Let's describe this utility function. Unlike the previous model, his wage is a function of his productivity (and the exchange rate in case of gold farming industry)[10]. Let this function be increasing in w. Again, $v^i(l)$ with $i = v, r$ denotes disutility from work in particular industry. Our worker chooses his work according to following function

$$U = max\{U_r, U_v\}$$

Now we analyze both possibilities.

In case of real sector we can assume that his productivity is proxy variable for worker's abilities, qualification and education. If we consider a poor worker, it's probable that his education isn't good. If he is unqualified, his productivity and following wage will be low. Second term in our equation denotes disutility from work. Conditions for unskilled labor force in developing countries are hard. The workplaces, where workers suffers from bad labor enviroment, are called sweatshops. Hence we can assume that his disutility from work is high.

[10]Why this potential gold farmer differs form a gold farmer in the previous model? In the previous model we implicitly assumed that player has got an access to a computer, copy of a MMORPG, internet connection. If we consider poor worker from developing country, we assume he joins gold farming company and receives wage.

Now we focus on working in gold farming industry. In this case we presume that productivity is amount of virtual assets, which the worker can collect. Heeks (2008) wrote that the workers in gold farming industry are paid based on their results. It is compatible with our model. Moreover, Heeks (2008) states that wage paid in gold farming company is higher than minimal wage in developing countries, althrough it is low from Europian point of view. Now we look - as in previous case - on disutility from work in gold farming industry. It's probable that sitting in front of a computer is easier work than mining (especially if we consider reputation of mines, for example in China[11]) or working in textile industry or Apple factory[12]. In the previous model we had so-called moral costs in our equation. Then we stated that a gold farmer doesn't face them, because his only motive is profit. If we look at situation of unskilled poor worker in China, we can assume that facing hate of MMORPG's players is his last worry. On the other hand if the exchange rate increases (thus virtual currency becomes cheaper), then the worker receives lower wage.

From our previous text it's probable that $U_r < U_v$ for unskilled labor force in (at least in some of) developing countries. We can guess that in developed world is opposite situation (because of social state, labor protection, ….). For this reason we cannot be suprised that majority of gold farmers are from the developing country - namely from China. Heeks (2008) states that about 80 % of gold farmers are from this country. Hence majority of gold farming companies operates there. And that's the reason why we considered a worker from a developing country. Next chapter of the thesis is dedicated to the issues of these companies.

[11] http://www.chinamining.org/News/2010-04-02/1270190845d35206.html

[12] http://www.dailymail.co.uk/news/article-2096551/Apple-shamed-Chinas-iPod-sweatshops-SIX-YEARS-expos.html

Chapter 3

Gold Farming - company, costs and exchange rate

3.1 Gold farming company - overview

In chapter 1 we explained the term gold farming and described history of gold farming industry. In chapter 2 we showed worker's decision to be part of gold farming company. In this chapter we briefly describe the structure of a gold farming company and then we will focus on its revenues and costs. With help of theoretical model we show, which variables affect the exchange rate. At last we will show how changing exchange rate affects income statement of gold farming company.

Organisation of a firm

Reason, why companies are created, is transaction costs (Coase 1937). Transaction costs are relatively small in gold farming (Heeks 2008). This fact stems mainly from the use of the Internet. It causes the cost of acquiring information is low and because of the nature of the process it eliminates transaction costs of the contracts[1] (Heeks 2010). The reason why the companies specializing in gold-farming activities exist is more likely returns to scale (Heeks

[1] On the other hand Heeks(2008) states that there is another type of costs, which are connected with reputation - gold farming is semi-illegal activity, thus there has to be trust between counterparties - neither one party can go to a trial.

2008). Many workers are needed for the effective acquisition of virtual goods plus some activities require larger amount of players. Basic gold farming (in other words primitive killing and selling) is against all expectations a simple mechanical activity that does not require any qualifications or skills. On the other hand, advanced techniques (for example using in-game auctions) have got some requirements on human capital. Workers are paid based on the results (Heeks 2008). Further, they need coordinators, who maintain the company in operation. Therefore, there is a specific hierarchy in gold farming companies (Heeks 2008). Aside from the workers there are managers, who lead the company plus people, who try to optimize gold farming procedures (Heeks 2008).

Gold farming supply chain

In the text above the structure of a company was described. The following text deals with the company's place in the broader chain of other interest groups. Swaminathan, Smith and Sadeth (1998) define supply chain as "*a network of autonomous or semiautonomous business entities collectively responsible for procurement, manufacturing and distribution activities associated with one or more families of related products*". In gold farming industry it has got the following form according to Heeks (2008):

- **IT suppliers** provide technical aspect of the business.
- **Gold farming companies** produce virtual assets. They buy labor from their workers and sell output to brokers, or directly to the customers.
- **Retailers** are the mediators, who convey final good to the customers. Virtual assets retailers are either exchange servers (for example Swagvault) or virtual characters, which demand it straight in the game. In the case of gold farming **brokers** mediate virtual assets and are involved in the business directly, unlike the **exchangers**, who are not engaging directly.
- **Marketing element** takes various forms. It can be in-game spammers, pursued by operators, or fan servers, which are operated by the participants of RMT.
- **End consumers** are players of MMORPG, who use services of RMT providers.

The advantage of this business is that thanks to the virtual nature of the goods, no costs must be paid for transporting goods and their storage. Thus supply chain is simpler than in other industries (Lehdonvirta & Ernkvist 2011).

In addition to these interest groups directly involved in RMT, there are other more or less pronounced relationships to the business. At first there are players, who are not involved in RMT (they were in model in chapter 2, hidden in n). Then government, whose attitude to RMT varies from lack of interest to reluctance, and last but not least operators of the MMORPGs, who indirectly co-create this business and whose influence is described in chapter 4.

3.2 Costs and revenues

Previous pages brought general information about the structure of gold farming company. Now we examine it from the point of view of revenues and costs. Gold farming company is a firm in microeconomic sense: it creates output (virtual currency) with help of inputs. For the purpose of our analysis we will use only two outputs - labor and capital.

Labor and Capital

Definition 1 (Capital) *Durable goods capable of producing a stream of goods or services over a period of time.* [2]

In the case of gold farming following aspects can be embraced in capital. At first computers, which are key production factor for gold farming. Minimal requirements given by game must be satisfied or PC cannot be used. Another items are computer games - price depends on a current game, on which company is specialized. The most common PC game involved in capital is World of Warcraft[3]. Last but not least we have to mention human capital, or skills and experiences of the workers. In this case it means ability to understand the nature of a game (Heeks 2008). Second production factor is labor.

Definition 2 (Labor) *A factor of production which consists of the effort and time of human*

[2] definition from Rutherford D. *Routledge Dictionary of Economics*,3rd ed., Routledge,2005

[3] because WoW is the most popular MMORPG, as we wrote in the first chapter

beings engaged in the production of goods or services. [4]

For the purpose of gold farming we can consider mainly the earning of virtual assets - it is provided by a mass of ordinary workers. It constitutes the majority of firm's labor. Then there are salaries of the managers and in some companies there are technical experts, who take care of company's computers (Heeks 2008).

Costs

In case of gold farming the cost of capital can refer to following items. At first it's the price of computers, which is permanently decreasing. Gold farmers can use overhauled computers too. Luckily for them, MMORPGs have usually got low hardware requirements [5]. Then there are internet and electricity fees, which vary from country to country. In China internet fees are relatively high [6] - until 2012 there was monopoly[7]. Then there are damages caused by deleted accounts[8] - that's specific type of costs. Creating of new account (contrary to creating of new virtual character) isn't free plus gold farmers lost their gold, items and especially virtual characters[9]. Cost of labor represents mainly wages of ordinary workers, which constitutes the majority of costs of labor. As it was mentioned above, wages of ordinary Chinese gold farmers are relatively small compared to Western standards (Heeks 2008).

Revenues

There are two stages, which are needed for earning money in gold farming industry. In the first one gold farmer has to collect virtual currency. Second stage is about selling it for real money. First stage depends on gold farmer's abilities, whereas second stage is dependent on the exchange rate, which we mentioned already in chapters 1 and 2. Hence at first we briefly describe obtaining virtual assets and then we focus on change in exchange rate. The following text describes main methods of obtaining virtual gold in MMORPG[10]. Let's assume

[4] definition from Rutherford D. *Routledge Dictionary of Economics*,3rd ed., Routledge,2005

[5] for example World of Warcraft - http://www.xzone.cz/nahledgame.php3?idg=2528

[6] http://www.wantchinatimes.com/news-subclass-cnt.aspx?cid=1102MainCatID=id=20120501000061

[7] http://www.chinadaily.com.cn/china/2012-03/15/content_14843546.htm

[8] Deletion of player's account is popular method of fighting against RMT, the method itself is discussed in chapter 4

[9] as is written in World of Warcraft EULA

[10] For purpose of the thesis we deal with World of Warcraft gold farming based on personal experiences.

for the purposes of our analysis that the player will sell items with maximum gain and thus the only variable which we calculate are gold coins. Almost all enemy NPCs carry a certain amount of either virtual money or tradable items (or both). From my experience there is a positive correlation between a monster's amount of gold and its toughness. Aside from the gold some creatures have got items, which are special for their kind. An example could be a monster called "sand basilisk." The basilisk is relatively tough to kill, in the game this fact is represented by the 46th level[11]. On this basis, the player finds appropriate amount of money - in my experience from two to five silver coins. In addition, however, lots of the basilisks have got "sand basilisk scale", an item that no other species owns. Hence when we sell this item we found, selling price of this item plus the silver coins mentioned earlier gives us a total revenue for killing the basilisk. It should be noted that the yield of all the Basilisk lizards is not the same. Other sources of wealth are quests[12] given by NPCs. In World of Warcraft the reward has always a form of virtual money, and often player can often choose from several items. Popular method of acquiring gold is through crafting. Examples of the crafts in World of Warcraft were given in chapter 1. Another possibility of earning gold is through selling virtual items in Auction House, which was mentioned in chapter 1 too.

Second stage - sale of virtual currency - consists of arrange of a deal with buyer (passive RMT user), delivering goods to customer and receiving payment from the customer. The supply chain mentioned earlier affects it as well as the exchange rate.

3.3 Model of supply-demand chain in gold farming industry

Overview

Now we try to employ previous knowledge into an overall model of gold farming industry. We assume a supply chain with three counterparties - gold farming company on supply side, passive RMT user on demand side and between them mediator - exchange server, which is known from beginning of this chapter. Let this chain have the following form.

[11] Level is indicator, which shows degree of virtual character's power (avatar's as well as NPC's),see Appendix

[12] A quest is a task given to a player character that yields a reward when completed.(www.wowwiki.com/quest),see Glossary in Appendix

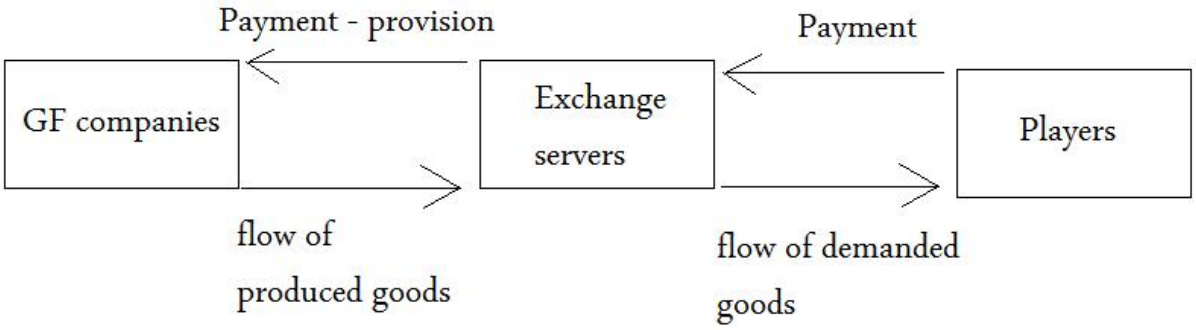

Figure 3.1: Supply-demand model with mediator

Our task is to theoretically show how the exchange rate between virtual and real currency is made. At first we describe all parts of this model.[13]

1. Gold farming company sends **produced** (collected) virtual goods to exchange server. We denote this amount as $Q^s = S(P, F, A)$, where S is increasing in P (price of virtual asset, which is paid to gold farming company by an exchange server) as well as it is decreasing in F, which in this case denotes the price of production factors (which were stated earlier). Variable A is proxy for inconvenience for gold farming in particular MMORPG[14]. We assume that function is decreasing in A. The expedition costs $F \cdot S(P, F, A)$.

2. Exchange server sends amount of **demanded** virtual assets. We denote this amount as $Q^d = D(ex, Y)$. We presume that the demand is decreasing in the exchange rate and increasing in Y (player's real income, from previous model $W + w \cdot l$). Player pays the amount of money, which is equal to $EX \cdot D(ex, Y)$, where ex denotes the exchange rate between virtual and real currency.

[13] In chapter 2 we operated with exchange rate between real and virtual currency(EX) - from the point of view of buyer (player). On the other hand now we operate with exchange rate between virtual and real currency (ex), which denotes amount of real currency, which gold farmer obtains for one unit of virtual currency, thus $ex = \frac{1}{EX}$. From this chapter until the end of the thesis we follow this meaning of the exchange rate.

[14] In other words - how difficult is to run gold farming business in particular MMORPG.

3. Gold farmer receives part of revenue from previous transaction, whis is equal to $P \cdot D(ex, Y) = (1-\tau)ex \cdot D(ex, Y)$, where τ is provision of exchange server for arranging the deal.

If we assume that supply is equal to demand, then we will obtain following system of equations.

$$\begin{aligned} Q^s &= S(P, F, A) \\ Q^d &= D(ex, Y) \\ Q^d &= Q^s = Q \\ \Pi^{gf} &= P \cdot D(ex, Y) - F \cdot S(P, F, A) \\ \Pi^{es} &= ex \cdot D(ex, Y) - P \cdot D(ex, Y) = \tau \cdot ex \cdot D(ex, Y) \end{aligned}$$

First two equations we mentioned above. The equation $Q^d = Q^s$ expresses equilibrium, where supply is equal to demand. Fourth equation and fifth equation denotes gold farmer's profit (respectively profit of exchange server). In this model we assume that the exchange rate is set through relationship $ex = \frac{P}{1-\tau}$. Moreover, we assume that τ is set by exchange server. If we substitute third equation into fourth one, we obtain

$$\Pi^{gf} = (P - F) \cdot Q$$

Another assumption is that F, A and Y are given exogenously. We will assume that $P > F$, otherwise company would not operate. Our task is to show relationship between P (EX respectively) and other variables. Then their changes and shocks will be discussed.

Effect of cost of production factors and player's income

If supply is equal to demand, then[15]

$$S(P, F, A) - D(ex, Y) = 0$$

with previously mentioned relationship between price and exchange rate we obtain

$$Z = S(P, F, A) - D(\frac{P}{1-\tau}, Y) = 0$$

[15]based on http://www.math.northwestern.edu/ clark/285/2006-07/handouts/implicit.pdf

We can use implicit function theorem. In this case Z_y denotes function Z differentiated with respect to y. Let's begin with production factors F.

$$\frac{dP}{dF} = -\frac{\frac{\partial Z}{\partial F}}{\frac{\partial Z}{\partial P}} = -\left(\frac{S_F}{S_P - D_{ex} \cdot \frac{1}{1-\tau}}\right) > 0$$

Previous inequality holds because $S_P - D_P \cdot \frac{1}{1-\tau} > 0$ and $S_F < 0$, as we know from earlier time. Now we continue with income Y.

$$\frac{dP}{dY} = -\frac{\frac{\partial Z}{\partial Y}}{\frac{\partial Z}{\partial P}} = -\left(\frac{-D_Y}{S_P - D_{ex} \cdot \frac{1}{1-\tau}}\right) > 0$$

At last we examine effect of A on the price set by the gold farmer company.

$$\frac{dP}{dA} = -\frac{\frac{\partial Z}{\partial A}}{\frac{\partial Z}{\partial P}} = -\left(\frac{S_A}{S_P - D_{ex} \cdot \frac{1}{1-\tau}}\right) > 0$$

Our results say that if firm's cost increases, then firm has to increase price of virtual currency too. If income of the players increases, then gold farming company increases the price. Same situation is with A, which will be examined in the last chapter.

Relationship between price and exchange rate

At the beginning of our analysis we assumed (and related literature justifies it - Heeks(2008) for example) that exchangers (mediators) set mark-up on price of gold farming company.

$$ex = \frac{P}{1-\tau}$$

From this equation it's clear that increase of F,A or Y causes increase of the exchange rate. Heeks (2008) cites Dibbel (2007) and Yee(2006), who state that mediators set $\tau = 47$ % (Dibbel), respectively 62 % (Yee). It's clear that with an increase of price the exchange rate rises too. At last we can see that vertical integration (acquisition of distribution channels) is a good idea.

Changes in exchange rate

Until now we implicitly assumed that exchange rate is static. In chapter five we will show that it isn't true (we use data from exchange servers, which show dynamics of exchange rate). But now we try to analyze reasons why price and thus exchange rate changes through

variables, which we choose as determinants of supply and demand. We don't take inflation[16] into account. At first we assume changes in customer's income - positive or negative demand shocks (the term $W+w\cdot l$, known from chapter 2, increases or decreases). In case of production factors as well as player's income we can distinguish many reasons. When we study neoclassical microeconomic theory, we realize that it concedes the possibility of increase of the price of the production factors with entry of new firms into the industry[17]. If we focus on price of production factors one more time, main concept of economic theory - scarcity - implies that if some production factor diminishes, then its price increases[18]. If we look at *gold farming supply chain*, we mentioned three parties, which affect gold farming and RMT. They are players, who are not involved in RMT (their presence lowers utility of RMT users - from model in chapter 2), governments and especially operators of MMORPGs, whose majority is against RMT and thus against gold farmers too. We will discuss their motives and measures in chapter 4. Now we state following hypothesis:

Hypothesis 1 *Operator's actions (at least some of them) affect the exchange rate.*

We will deal with this hypothesis in chapter 5. Now we have to say that its core comes from the previous model, where we added variable A, which is heavily affected by the operator himself.

3.4 Income statements

In the previous section we discussed firm's revenues and costs generally. Pages below provide an estimate of income statement of an average gold farming company plus estimate of income of a single gold farmer. The first one is from China (2006), the second one is from Czech Republic (2012).

[16]Neither real world inflation, nor inflation, which takes place in virtual economies. For readers interested in virtual inflation I recommend Skuhrovec (2009).

[17]Koubek I., Microeconomics - lecture notes, IES

[18]Samuelson, P., Nordhaus W., Ekonomie. 18th edition, Praha: Svoboda, 2007.

Income statement in 2006

Following balance sheet estimated Zhe in 2006. It is based on gold farming company that has got 10 employees plus one manager. The company is specialized on World of Warcraft. According to Zhe (2006) it has got these properties:

Expenditure Items	**Expenditure ($)**		**Income Items**	**Income ($)**
Worker wages	1 205		Gold sales	10 200
Food	360			
Rent	360			
US proxy server rental	300			
Manager wages	180			
Games subscription	150			
Internet connection fees	145			
Electricity	90			
Total	2 790		Total	10 200
Profit				7 410

Source: Zhe (2006)

Following information comes from Zhe(2006). Workers labour 12 hours per day. Average amount of gold coins per one employee is 200 g per 12 - hour working day, thus roughly $16,7$ g per hour[19]. Gold farming company sold them for 17 $ per 100 g. Heeks (2008) comments that almost 50 percent of costs are worker wages. Revenues - costs ratio is

$$\frac{Revenues}{Costs} = \frac{10200}{2790} = 3,65 = 365\%$$

It means that profitability is extremely high. However, owners of the company obviously share this profit with mediators, as we wrote above.

[19]Note that these figures are from 2006, now it's possible to earn more gold.

Income statement 2 - Czech Republic

Now let's try to replicate the income statement for Czech Republic in 2012. With estimation of the costs I will use characteristics of my personal computer. Following costs will be in Czech Crowns. Contrary to previous income statement we assume single gold farmer from Czech Republic

At first there is an electricity fee, counted per kilowatthours. I measured that average electricity consumption of the computer is 3 kwH per 24 hours[20], while running on maximum. The price of electricity is 4.6 per kwH. If we assume that month has got 30 days, then electricity fee for running of computer is $30 \cdot 4,64 \cdot 3 =$ **417,6**. Now we discuss other two important fees - internet connection fee and game (World of Warcraft) subscription fee. In my case the first one is 350 per month. In Czech Republic World of Warcraft subscription fees are around 300 per month[21]. Hence month costs per my computer are $417,6+350+300 =$ **1067,7**.

Now let's look how big should productivity of virtual asset be. For simplicity let's assume that there are no transaction costs, the only virtual asset is currency (gold) and that exchange servers buy gold at the same price they sell it (provision τ is zero). Now we use data[22] to determine this break-even revenues in longer period - from the beginning of 2009 to the end of 2011. In graph below we see expected monthly costs known from the previous text (but now in dollar), which change with daily USD/CZK[23] exchange rate.

[20] calculated with help of *http://www.extreme.outervision.com/PSUEngine*

[21] http://www.xzone.cz/nahledgame.php3?idg=1165

[22] from exchange server, we randomly chose realm (see glossary in Appendix) Aggramar

[23] data source: www.cnb.cz, expected montly costs denote how big are monthly (30 days) costs if both exchange rates are constant.

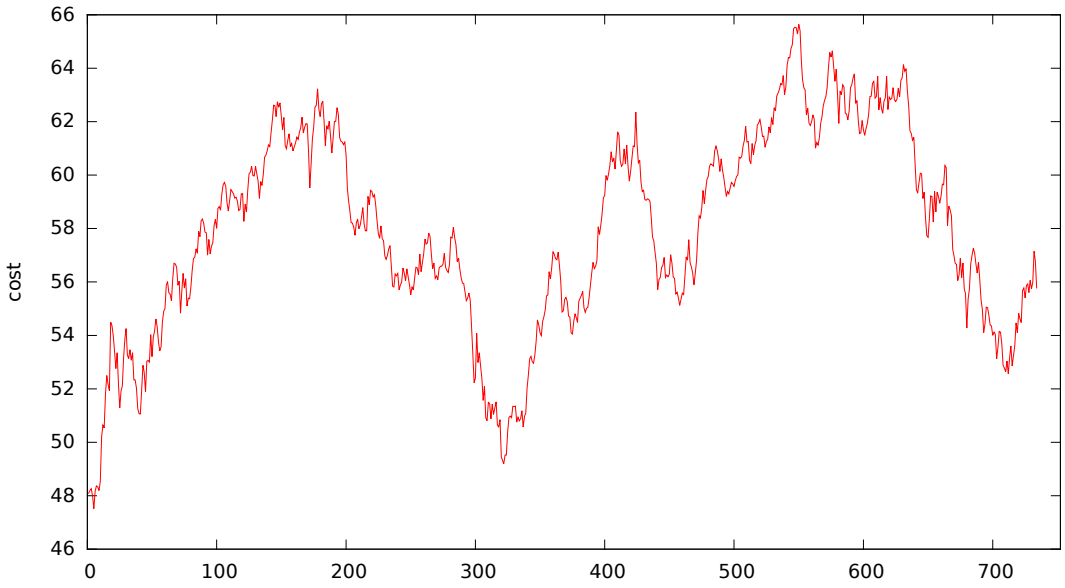

Figure 3.2: Costs of hypothetical czech gold farming company (2009 - 2012)

Now we look at expected monthly break-even revenues (in gold), which (as in the previous case) depend on the USD/CZK exchange rate as well as exchange rate between virtual and real currency[24]. We use following formula

$$productivity_t^{BE} = \frac{cost_t}{ex_t}$$

In words - cost(measured in dollar) in time t divided by exchange rate between virtual and real currency in t.

[24]data source will be discussed in chapter 5

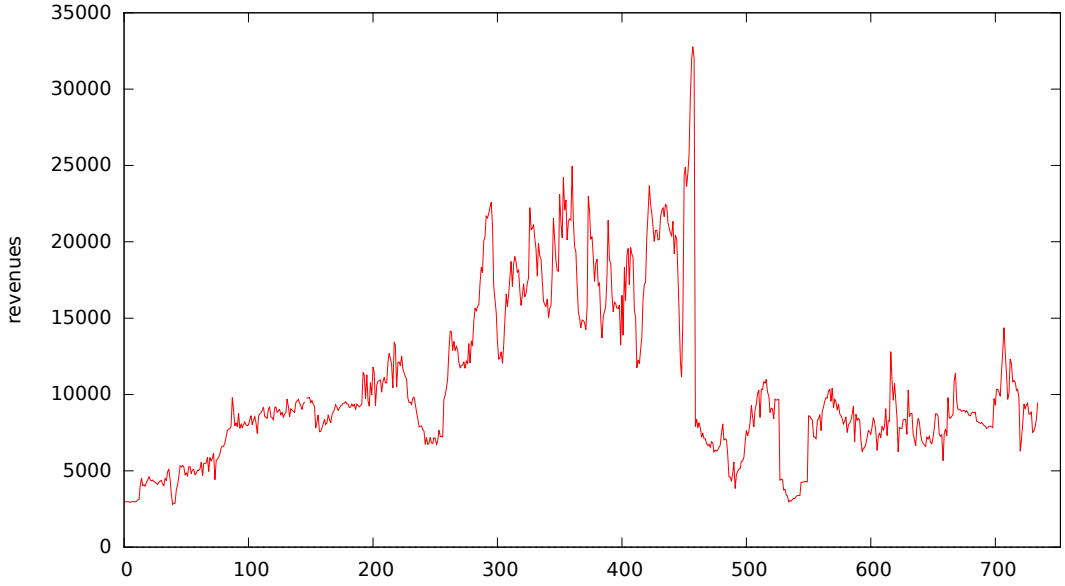

Figure 3.3: Break-even gold revenues (2009 - 2012)

The *figure 3.3* above shows the necessary amount of gold, which is needed to collect per month to cover the costs. As we can see, the necessary amount of gold, which we have to collect, varies through the time - from 5000g to 35 000g.

Model with inflation

In previous model we didn't take into account inflation in real world. But now we will calculate with it. Let's have (as in the previous text) single gold farmer, who has got simple profit function in the following form

$$\Pi(t) = ex(t) \cdot Pr(t) - C(t)$$

Let's describe those variables - t denotes time, *ex* is exchange rate between virtual and real currency(dynamic and exogenous, contrary to previous assumptions), Pr is productivity and

C denotes costs[25]. Dynamic productivity means that player becomes better when he spends more time in the game. Moreover, let's assume that productivity function is concave, thus the increments of productivity decrease. Contrary to this, we have no assumption about the exchange rate development (except that the function is continuous) Now we employ constant inflation π, which makes our costs dynamic too. Let's assume that

$$\frac{\partial C}{\partial t} = \dot{C} = \pi \cdot C(t)$$

If gold farmer wants to have positive profit in period t, then he has to satisfy the following condition[26]

$$\begin{aligned} \frac{C(t)}{ex(t) \cdot Pr(t)} &< 1 \\ \ln C(t) - (\ln ex(t) + \ln Pr(t)) &< 0 \end{aligned}$$

If we differentiate it with respect to t, then

$$\pi < \frac{\dot{Pr}}{Pr} + \frac{\dot{ex}}{ex}$$

In words - inflation has to be lower than the percentual growth of player's ability plus percentual growth (decline) of the exchange rate. But we assume that $Pr(t)$ is concave and thus the percentual increments of the player's ability will be lower and lower. Thus if there are no positive development in exchange rate (i.e. its increase), then gold farmer starts to have a loss. Thus the exchange rate become more imporant through time for the single gold farmer.

The aim of this subsection was to show the impact of exchange rate on balance sheet. We showed on data that necessary revenues(counted in gold) are heavily affected by the exchange rate. Moreover, we showed that if we consider that costs are increased by inflation, then single gold farmer becomes more and more dependent on this rate. Next chapter shows possible source of its changes - operator of MMORPG.

[25]Problem is that the exchange rate is changing in real time,whereas gold farmer's productivity increases with time spending in MMORPG. Hence we will assume that in this case real time is proxy for in-game time.

[26]we assume that neither ex nor Pr are zero as well as C

Chapter 4

Regulation of RMT: gold farmers VS operators and governments

In chapter 2 we showed that the exchange rate between real and virtual currency is an important variable, which affects decision-making of the players. Now we try to identify one of the main sources of (potential) disturbance of the variable - operator's actions against gold farmers. This chapter should answer three basic questions:

1. Why would a company wanted to fight RMT?
2. What methods are used for regulation?
3. How the governments approach RMT and gold farming?

In the second part of this chapter we focus on Blizzard - operator of World of Warcraft.

4.1 Regulation: theory and reality

As we wrote earlier, the majority of online game operators struggle against gold farming. In this section we will show the reasons why. We will focus on the impact of gold farming on operator's profit. There is a big problem with data - it is almost impossible to identify the amount of money, which operator lost because of the mentioned activity. However, we can describe this problem with help of theoretical concept.

Operator vs gold farmer - game theory approach

Game theory is a valuable tool for analyzing interaction between the subjects. Central part of this chapter is dedicated to game theory based model, which describes interaction between gold farmer and operator of a MMORPG. Aim of this analysis is to discover when it is advantageous for the operator to provide RMT as well as pursuing gold farmer. At first we look at the picture below, where is the game itself.

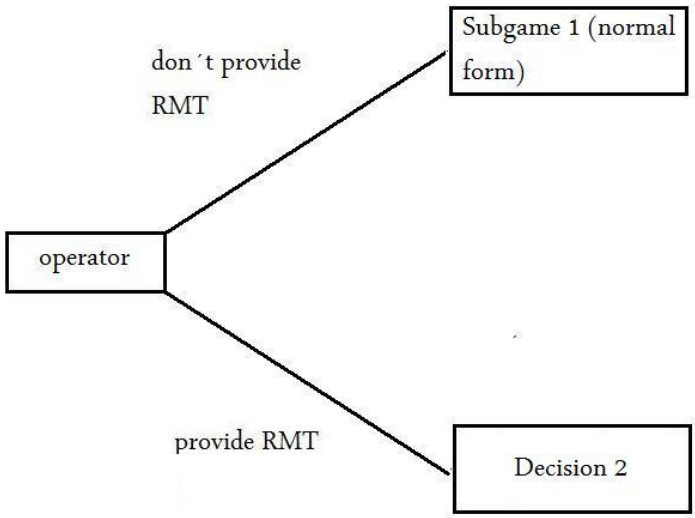

Figure 4.1: Operator VS gold farmer: whole game

As we can see, it is a combination of extensive and normal form of a game. In the first step the operator decides whether he wants to provide RMT on his own, or not. If we say "providing RMT by operator", we mean that the operator offers players to buy virtual items (or currency) for real money officially from him. We will assume that if the operator provides RMT on his own, then his marginal cost is zero. This assumption is built on fact that the operator runs MMORPG and he is able to add any item he wants through programming. One of these decisions leads into another game, now in normal form and production decision. Our analysis is divided to three main steps. At first we solve subgame, then production decision and then with help of obtained results the whole game will be solved.

FIRST STEP: Subgame 1 - Operator doesn't provide RMT

At first we analyze the possibility that operator does not provide RMT. It will be made with the help of a game in normal form.

Players

Gold farmer and operator of MMORPG.

Strategies

Gold farmer can run gold farming or not. Operator adjudicates if he fights it or not.

Payoffs

Let X be gold farming company's income, C - cost of fighting against gold farming, β_s is sensitivity of ordinary players to operator's inactivity toward gold farming (in other word proxy variable for the amount of leaving disgusting players), p is the probability of the gold farmer that he or she will be punished (if operator fights) and B denotes harshness of punishment itself. At last F is subscription fee, which ordinary players pay for playing the MMORPG, which the operator provides. In this model let's assume that operator fights with gold farmer only in cyberspace and thus the operator has no direct profit from harm. Moreover, all variables have to be higher than zero (or equal). It's trivial in the cases of C,F,B. In the case of p, we know that it is probability and thus it has to be between 0 and 1. A little bit more complicated situation is with sensitivity. Negative value could be interpreted in terms of gold farming attracting new players. Nevertheless, we will presume that this value is positive. Payoffs are in matrix below.

Let's describe these particular situations one by one. If gold farmer operates in MMORPG and operator tries to fight it, then expected payoff of the gold farmer decreases because of the probability of getting caught. Operator pays cost of fighting as well as in case that gold farmer is not active. In this case gold farmer's payoff is zero. If the gold farmer is active and the operator isn't, then the first mentioned of them obtains full income X, while the operator

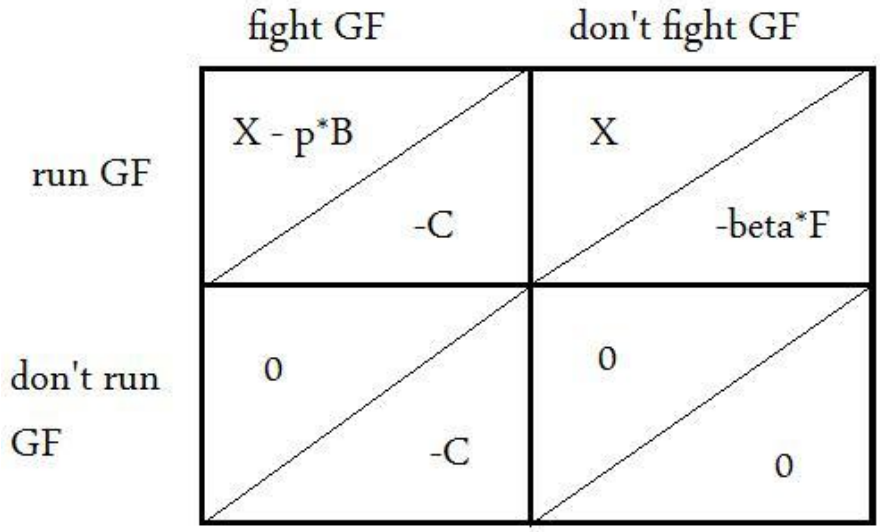

Figure 4.2: Operator VS gold farmer: subgame 1 - normal form

faces outflow of disgusted players from his game. Proxy for this outflow is sensitivity β_s, total loss is sensitivity times subscription fee. Now we try to solve the game. At first we recall definition of Nash equilibrium

Definition 3 *The strategy profile is a Nash equilibrium if no player has incentive to deviate from his strategy given that the other players do not deviate.*[1]

Nash equilibrium is the easiest and the most intuitive solution of the game. There is no general Nash equilibrium, which holds for all values. Nash equilibrium exists only in these cases

1. If $X > pB$ then strategy *run RMT* dominates *don't run RMT*. Moreover, if $C < \beta_s F$, then strategy (run GF, fight GF) is Nash equilibrium.

2. If $X > pB$ then strategy *run RMT* dominates *don't run RMT*. Moreover, if $C > \beta_s F$, then strategy (run GF, don't fight GF) is Nash equilibrium.

[1]RASMUSEN E., *Games and information: an introduction to game theory.* 4th ed. Malden, MA: Blackwell Pub.; 2007. xxix, 528 p.

3. If $C > \beta_s F$ then strategy *don't fight GF* dominates *fight RMT*. Then strategy (run GF, don't fight GF) is Nash equilibrium.

Thus we have to find the equilibrium in mixed strategies for case $X < pB$ and $C < \beta_s F$.

At first we express probabilities of particular actions. Let's denote the probability of operator's fighting against gold farming with θ, thus probability of operator's inactivity will be $1 - \theta$. We will do it similarly with the probability of running gold farming operations in MMORPGs. We denote it γ. It implies that opposite state will be $1 - \gamma$. Let's write operator's profit in following form[2]

$$\Pi^{operator} = \theta(\gamma(-C) + (1-\gamma)(-C) + (1-\theta)(\gamma \cdot (-\beta_s F) + (1-\gamma) \cdot 0)$$

If we differentiate it with respect to θ, we will obtain

$$\frac{\partial \Pi^{operator}}{\partial \theta} = \gamma(\beta_s F) - C = 0$$

The last term can be rearranged into

$$\gamma^* = \frac{C}{\beta_s F}$$

Previous equation says that probability of running gold farming is increasing in C and decreasing in β_s and F. It can be interpreted in the way that gold farmer assumes that an increase of costs discourages the operator from fighting. Contrary to this fact an increase of F causes a decrease of operator's potential profit. An increase of β_s indicates that players became more sensitive to manifestation of RMT, thus it's more probable that operator will fight

Now we will do a similar operation with gold farmer's profit to find the probability of fighting against gold farming.

$$\Pi^{goldfarmer} = \theta(\gamma(X - pB) + (1-\gamma) \cdot 0) + (1-\theta)(\gamma \cdot X + (1-\gamma) \cdot 0)$$

[2]Rasmusen,E., *Games and information: an introduction to game theory*, 4th ed. Malden, MA: Blackwell Pub.; 2007. xxix, 528 p.

Again we differentiate, now with respect to γ

$$\frac{\partial \Pi^{goldfarmer}}{\partial \gamma} = -\theta pB + X$$

Again, the last term can be rearrange into

$$\theta^* = \frac{X}{pB}$$

If X increases, then the probability θ arises too. It can be interpreted that an increase of gold farmer's profit motivates gold farmer to higher activity, thus it's better to fight him. Increase of p and B, on the other hand, discourage gold farmer from providing this business and lower probability θ that operator strike against gold farmer. Now we examine expected payoffs of the gold farmer and the operator in mixed strategies[3].

$$\begin{aligned} \Pi^{goldfarmer} &= \theta \cdot (X - pB) + (1 - \theta) \cdot X = -\frac{X}{pB} \cdot pB + X = 0 \\ \Pi^{operator} &= \gamma \cdot (-C) + (1 - \gamma) \cdot (-C) = -C \end{aligned}$$

From previous equations we can see that $\Pi^{operator} \leq \Pi^{goldfarmer}$ in mixed equilibrium. At the end of the analysis of this game we can deduce one conclusion. Let B and β_s are given exogenously. Moreover, C, F and p can be affected (or directly set) by the operator. Our conclusion is that if $X < pB$ and operator invents some anti-gold farming mechanism, which decreases cost to $C = 0$, then the probability of running gold farming in operator's MMORPG is zero and thus gold farming will be wiped out.

SECOND STEP: Operator provides RMT

Second option means that the operator is involved in RMT directly. We can establish a very simple model of the operator, who provides RMT. Let's write profit from gold farming prosecuted by its own operator in the form

$$\Pi = \Pi^{op}_{mon} - \alpha_s \cdot F$$

[3]based on RASMUSEN E., *Games and information: an introduction to game theory.* 4th ed. Malden, MA: Blackwell Pub.; 2007. xxix, 528 p.

where Π_{mon}^{op} is profit function, which shows the operator's profit from RMT, α_s is sensitivity of the players on RMT provided by the operator (similar to β_s, but we can assume that $\alpha_s >> \beta_s$ - the players are more disgusted by the official providing of RMT by the operator than simple tolerating) and F denotes subscription fees of the particular MMORPG. Assume that the operator is a monopolist in its own MMORPG without an ability to discriminate customers. The assumption of the operator's monopoly is based on the previous assumption of zero marginal costs, thus he will force ordinary gold farmers out. Let demand for virtual assets is characterized by a following function [4]

$$Q(P) = a - b \cdot P$$

where $a > 0$ and $b > 0$ are the constans and P denotes price of virtual assets. Thus

$$P(Q) = \frac{a - Q}{b}$$

Moreover, let total cost function TC consists only from fixed cost, thus first derivation is equal to zero (operator can summon virtual asset without cost). In an optimum quantity following equation holds

$$\frac{\partial(\frac{a-Q}{b} \cdot Q)}{\partial Q} = 0$$

$$\frac{a - 2Q}{b} = 0$$

$$Q^m = \tfrac{a}{2}$$

From the last equation it's clear that the optimal quantity does not depend on the slope of P(Q), which is b. The optimal price denotes equation

$$\begin{aligned} P &= \frac{a - Q}{b} \\ P(Q^m) &= \frac{a - \frac{a}{2}}{b} \\ P^m &= \frac{1}{2} \cdot \frac{a}{b} \end{aligned}$$

[4] for example Koubek, I., *Microeconomics*, lecture notes, IES

With knowledge of P^m and Q^m we derive operator's profit from RMT

$$\begin{aligned}\Pi^{op}_{mon} &= P^m \cdot Q^m - 0 \cdot P^m - FC \\ \Pi^{op}_{mon} &= \frac{1}{2} \cdot \frac{a}{b} \cdot \frac{a}{2} - FC \\ \Pi^{op}_{mon} &= \frac{1}{4} \cdot \frac{a^2}{b} - FC\end{aligned}$$

With substitution to original equation we obtain

$$\begin{aligned}\Pi &= \Pi^{op}_{mon} - \alpha_s \cdot F \\ \Pi &= \frac{1}{4} \cdot \frac{a^2}{b} - FC - \alpha_s \cdot F\end{aligned}$$

THIRD STEP: The whole game - solution

We know the payoffs from both decisions, thus we are able to solve whole game. Rational operator chooses the variant, which maximizes his total payoff. Thus

$$\text{Total Payoff} = max\{\text{Payoff from SUBGAME 1}, \text{Payoff from DECISION 2}\}$$

Generally we can say that operator's payoff from subgame 1 is loss from gold farmer's activity, either caused by cost of fighting RMT (C) or by loss of disgusted players ($\beta_s \cdot F$). Let's denote it $-L^{gf}$ With previous knowledge we can state that operator will provide RMT if

$$\frac{1}{4} \cdot \frac{a^2}{b} - FC - \alpha_s \cdot F > -L^{gf}$$

where L^{gf} is either C, or $\beta_s \cdot F$. In other words - operator will provide RMT in case that his total profit from RMT is higher than zero plus in case that his loss from providing RMT will be lower than loss caused gold farmer's activity.

According to this model operators of online role playing games have good reasons to fight RMT. Trade with virtual currency affects non-users of RMT too. As we wrote in chapter 1 there are people who have more real money than virtual wealth. Instead of gradual development of their own virtual characters, they buy a virtual characters created by someone else. Then they equip him with virtual items bought for real money, or directly in the current

game for virtual money, which they own because of services of gold farmers. We can a ask crucial question: why operators don´t start to trade with virtual assets on their own? The profit goes to firms from the monthly fees (represented by F in our previous model). Such behaviour could disgust part of other players, who would go to another operator and thus stop paying. Crucial variables are α_s and F. It's probable that the first mentioned one is exogenous and strongly depends on type of the players, which play operator's MMORPG. If the players are highly sensitive (in this case it means that operator's profit from gold farming will be lower than zero), then the activity of gold farmer brings loss to the operator, no matter what he does. This situation is valid only for role-playing games such as World of Warcraft. A different situation is in online games like Second Life and similar. The difference between them is that these games are based on the need to buy items for real currency and thus RMT is provided by the operator (Linden Lab)[5]. But MMORPG worlds are generally built on a complex system of skills and attributes of player's virtual characters. There is a competition and rivalry between players. In chapter 2 we defined the Achievers and the Killers, whose motivation is to be better than others. Moreover, we showed that there are moral costs, which lower player's individual utility from using RMT. Hence there can be group of players, who cannot use RMT because moral costs and they have to see how other players use it and become stronger because of it. This state causes their frustration and they leave MMORPG, where RMT is provided by operator. Similar situation can occur when operator tolerates RMT in his MMORPG.

4.2 Methods of regulation

Previous model implied that in particular case it's better for game operators to pursuit gold farming than to provide or ignore it. In this section we will discuss methods of fighting this phenomenon. This section follows previous game, namely the variant, where the operator doesn't provide RMT (thus he didn't wipe out gold farmers by his monopoly). Instead of it he pursuits them with various tools.

[5] http://secondlife.com/shop/?lang=en-US

Lawsuits

In chapter 1 we wrote, that some operators forbid gold farming and RMT in EULA. When player installs game, he has to confirm that he agrees with EULA. In table below there are cases, in which operator sued gold farming company, because it broke EULA and he wants to be compensated from this company. In this table we can see result of lawsuit between operator (first is a name of operator, which sued gold farmer in his MMORPG[6]) and RMT providers (second name in the table is a name of a company, which provided RMT in particular MMORPG). We can see that all lawsuits, which we found, were won by operator[7]. So we can deduce that the probability of winning the trial is high. However, there aren't many trials[8]. In chapter 2 we wrote that according to Heeks (2008) majority of gold farmers are from China. Neither one trial from our table is with Chinese gold farming company. Probably it's impossible to sue Chinese gold farming company for American operator.

lawsuit	**victor**
Blizzard vs MDY INDUSTRIES, LLC	Blizzard
Hernandez (= player against RMT) vs IGE	Hernandez
Blizzard vs Game Dollar LLC	Blizzard
JaGeX vs rsbot	JaGeX

Source *See Bibliography (Lawsuits against RMT)*

Deleting accounts and issuing patches

In the previous text we stated that lawsuits aren't common method of fighting RMT. Now we focus on two more frequently used methods. First commonly used retaliation against players using the services of RMT is blocking their accounts. Blizzard monitors individual user accounts. When it registers that player participates RMT, the account is recorded and deleted. The mass account deletions take place several times per year. When the mass deletion begins, then the accounts are liquidated in tens of thousands. For example - 67 000 accounts banned in 2006, 114 000 (together with Warcraft III), user accounts deleted in 2007, 59,000 accounts blocked a year later, 320,000 accounts (along with Warcraft III and Starcraft) disposed at the

[6]Blizzard is known to us from previous chapters, JaGeX provides MMORPG called Runescape.

[7]source: *Bibliography (Lawsuits against RMT)*

[8]At least we didn't find them.

beginning of 2010. [9] All virtual money, items and characters are removed from users.

Second popular method of fighting against RMT and gold farming is issuing patches[10]. They are automatically downloaded and implemented into the user's game, where they perform their purposes. Here is an example of how the patch may help in the fight against RMT. In 2007 the amount of in-game spam[11] rose sharply to promote the gold farming services. Blizzard released patch 2.1 immediately, which improved anti-spam protection. Hence spamming(and possible propagation of RMT) became harder.[12]. In the next chapter we analyze patch policy of the operator in detail.

Approach of the operators to RMT is slightly changing through time. Even Blizzard launched a special kind of business with real money - for a certain fee, players may change the properties of their virtual characters [13]. Moreover, they can buy certain items for real dollars. From the point of the players it is obviously not such a serious interference in the relations between players as in the case of classical RMT[14]. The question is: will Blizzard expand to provide this type of services? Through time new possibilities were added, for example since 2011 players are able to buy unique mount[15], but until 2012 RMT provided directly by the operator wasn't established in World of Warcraft. If we look at previous model, it implies that majority of players is still against it[16].

4.3 Governments and RMT

In the previous section we described the relationship between RMT and gold farming on one side and operators on the other side. We described gold farming as a specific form of busi-

[9] see Bibliography(Ban of the accounts)

[10] Additional program proposed by MMORPG's operator, which corrects errors in the game, alternatively adds new content. Unlike expansion pack it is free.

[11] in WoW: Sending an overly repeated message or large useless quantity of text in a Chat channel.http://www.wowwiki.com/Spam

[12] http://wow.joystiq.com/2007/05/11/spam-prevention-in-patch-2-1/

[13] http://www.wow.com/2008/12/12/blizzards-version-of-rmt

[14] Because until now it's limited - only small amount of items is allowed to buy for real money.

[15] http://wow.joystiq.com/2011/10/10/blizzard-introduces-tradable-guardian-cub-companion-pet-purch/

[16] Althrough it's hard to verify it empirically.

ness. It means that it could be taxable. Following pages bring short overview of taxation (or possible taxation) of this activity. In Czech Republic there is no taxation of real money trade or gold farming. But in some countries all over the world there are these attempts. We list there some of the most important examples.

At first we focus on South Korea's value added tax (VAT), was levied on RMT in 2007[17]. But we can say that RMT is controversial topic in South Korea. From 2007 to 2012 it was several times prohibited and allowed again. Recently, in June 2012 South Korea again banned it and related issues[18].

As was mentioned earlier, China is the centre of gold farming. Controversies with this activity and RMT generally were (and still are) also there. There was pursuing of QQ-coins - virtual currency, which began to extrude Chinese official medium of exchange. QQ-coins were reverse RMT - people bought real items for virtual currency. Thus using QQ-coins for buying real items was banned and since 2009 this country began to pursue the using of virtual currency to buying real properties (including real money) generally[19]. Situation with RMT was unclear until Chinese government imposed 20 percent tax on selling virtual items and de facto legalized it. [20] In 2009 one more new restriction was imposed on MMORPGs. Operators of these games must include special software in their games, which prevents long gaming to players, who are younger than 18 years [21]. After three hours they are disconnected and must wait for minimum another five hours because of time spent by playing MMORGPs (secondary effect is that it reduces ability to obtain larger amount of virtual currency).

Since 2006 there are discussions about taxation of buying and selling virtual assets in USA. These attempts became louder because of increasing popularity of the biggest online games - especially World of Warcraft and Second Life. In 2006, on Annual National Taxpayer Advo-

[17] http://www.mmorpg.com/blogs/gmtristan/072007/209_South-Korea-to-tax-RMT
[18] http://www.eurogamer.net/articles/2012-06-15-south-korea-bans-trade-of-virtual-items-gold-farm-bots
[19] http://english.mofcom.gov.cn/aarticle/newsrelease/commonnews/200906/20090606364208.html/
[20] http://blogs.wsj.com/chinarealtime/2008/10/31/real-taxes-for-real-money-made-by-online-game-players/
[21] http://www.examiner.com/mmorpg-in-new-york/china-re-enacts-anti-addiction-gaming-laws

cate's congress this possibility was mentioned too[22]. Until 2012 no tax was imposed .

The last example is from Australia. Since the same year like in USA similar debates took place in Australia. It was stated that trade with virtual assets can be taxed[23]. But until 2012 no arrangements were made to reach this goal.

It's probable that goverments are able to fight RMT more harshly than the operators. It's main reason why we mention their attitude toward RMT and gold farming. Hence if the government is afraid of RMT (if collected gold would be used for buying real items), then its actions probably affects costs of production factors mentioned in chapter 3 - for example an arrests of gold farmers would probably increase cost of labor and the companies would loose human capital.

[22]http://news.cnet.com/IRS-taxation-of-online-game-virtual-assets-inevitable/2100-1043_3-6140298.html?tag=item

[23]http://www.theage.com.au/news/biztech/virtual-world-tax-man-cometh/2006/10/30/1162056925483.html

Chapter 5

Updates and their impact

Fifth chapter brings empirical analysis of the exchange rate – the variable, which we examined in chapter 2 and 3 with help of economic theory. The chapter itself is organized in following way. At first we will make short review of literature, which deals with virtual economies from empirical perspective. Before we start analysis itself, we establish simple model of updating, which will be extension of model in chapter 3. Then we describe dataset, which we will use in this chapter, describe employed econometric method and execute analysis itself.

In the preface we wrote that there are only few academical papers, which deal with virtual economies. Now we have to state that situation with empirical papers, which focus on virtual economies, RMT or gold farming is even worse. We can state Lehtiniemi (2008) and Castronova et al. (2009), who examined macroeconomic indicators in virtual economies. More important for us is the paper written by Skuhrovec (2009). He focused on the price level in World of Warcraft economy and showed that it is influenced by EUR/CNY exchange rate as well as patches, which operator provides.

5.1 Theory of updates

Now we will establish theoretical background to phenomenon of game updating. Let's recall major model in chapter 3. In this model we have established variable A, which denotes anti-gold farming climate in particular MMORPG (not caused by other players, but by the game itself). With implicit function theorem we showed that increase of A causes increases of the

exchange rate between virtual and real currencies. But we didn't examine which factors affect this variable. Before the start of our empirical analysis we try to propose simple model of game updating. Let's A be function of following variables[1]

$$A = A(b, s, c,)$$

where b is proxy for difficulty of using bots[2] in the game, c is proxy for difficulty of spamming and c denotes proxy for difficulty of obtaing gold via crafting (or other similar activities). We can assume that the function is increasing in all three variables:

1. Bots are used by gold farmers for many activities (Heeks 2008).
2. More difficult spamming implies worse advertising[3].
3. Crafts are popular among gold farmers, thus when operator makes some of them difficult, it should imply worse obtaining gold[4].

Let's write change when update is issued in following form

$$dA = \frac{\partial A}{\partial s}ds + \frac{\partial A}{\partial b}db + \frac{\partial A}{\partial c}dc$$

Aim of the operator is to increase all three components of A to make RMT harder. On the other hand he is not all-knowing and he hasn't to disgust other players by extraordinary draconic measures. Hence it is possible that patch instead of increase of A makes its decrease. If $dA > 0$, then negative effect of ds, db, or dc prevails over potential positive effect caused by the patch, it makes RMT harder and according to our model established in chapter 3 it causes that the exchange rate increases. If $dA < 0$, then opposite phenomenon takes place.

[1] We know that it's big simplification of reality, because there are plenty of effects, but with the two of them we will work in empirical analysis.

[2] Bots are simple program, which are (in case of gold farming) use for simple mechanical collecting virtual currency.

[3] In-game spam is used by gold farmer, we have written it in chapter 3

[4] It's clear that ordinary players use crafts too, but probably they have got other hobbies in the game too, thus worsening of crafs damages gold farmers more.

In following empirical section we will examine three important updates of the most popular MMORPG of all time – World of Warcraft. First two of them are the patches, which contain important change of one of the parameters from equation mentioned above. The last update isn't ordinary patch, but the most recent expansion[5] of World of Warcraft – Cataclysm itself.

Before we start with analysis itself, we have to mention one important problem, which is connected with updating. It's difficult to predict the impacts of some measures on gold farming because in many cases they cannot be seen on first look. Good example is patch 4.0.1, which antecedes Cataclysm. Before this patch, there were ore excavations in location called Azshara. The patch caused that Azshara was ruined and the excavations were lost. It implied increase of c, because this place was popular among gold farmers and their bots[6]. As we can see, it's hard to theoretically evaluate the impact of a patch. Hence we will analyze those chosen patches, in which are significant and clear changes of one of the parameters mentioned above[7].

5.2 Empirical analysis

Data, which we will use, were collected from 24.02.2009. to 7.3.2012 in 27 realms[8] from the exchange servers[9]. The variables, which we will use, have got following meaning

- **EXv** denotes amount of US dollars, which exchange server obtains for 1000 gold.
- **Patch** is qualitative variable, which is **0** before particular update was released and **1** after the release.

[5] something like very big patch

[6] www.wowwiki.com/azshara

[7] We have to say that there are lots of patches in WoW.

[8] Realms are called the servers, where World of Warcraft runs. All realms contain the same world, buth with separate population. Realms are divided according to WoW geography version. Our dataset contains US realms (version for North and South America) and EU realms (version for Europe).

[9] Here I want to thanks to Jiri Skuhrovec for providing data.

In each of following cases procedure will be be same. Because of the nature of our data (time series + various realms) we use panel data econometric methods. Generally we will use following econometric equation[10]

$$EXv_{i,t} = \alpha + \alpha_i + \beta_j \sum_{j=1}^{p} EXv_{i,t-j} + \gamma Patch_{i,t} + \delta T + \varepsilon_{i,t}$$

In our case α_i is dummy variable of particular realm, i denotes particular realm and t is mark of time and T is time trend. We will use lags(autoregressive process AR(p)) of EXv too. All graphs, which are concerned with this chapter, are in Appendix B.

Patch 3.3.5 and Cataclysm

Now we jointly focus on patch 3.3.5 and Cataclysm. Patch 3.3.5 was released on 22th June 2010 (on US realms) and one week later on EU realms[11]. We will analyze the patch because it contains program Warden 2.0, which is against in-game cheating (which involves usage of bots). Hence we formulate following hypothesis.

Hypothesis 2 *Warden 2.0 made (at least for some time) production of gold harder. It implied increase of A, which was following with increase of the exchange rate between dollar and gold.*

Cataclysm was released on 7th December 2010. Its predecessor was patch 4.0.1, which prepared the virtual world on Cataclysm itself and which contained lots of changes (our previously mentioned Azshara example included). Hence we will include patch 4.0.1 into our econometric equation, but we will not interpret them. Now let's return to Cataclysm itself. If we want to predict his influence on the exchange rate, we have to go beyond model, which we established in chapter 3. Reason is that Cataclysm is very specific, because it has got significant impact on demand side of RMT - on productivity of all players. After its release players were allowed to reach up to 85th level, instead of 80th level[12] as before release. Hence higher level implies higher productivity of ordinary players. We formulate following hypothesis:

[10] For this part of the thesis Baltagi(2002) was used as a guide.

[11] http://www.wowwiki.com/Patch_3.3.5

[12] In chapter 3 we noted that the term level denotes degree of virtual character's power, thus they became more powerful.

Hypothesis 3 *Cataclysm increased productivity of all players in World of Warcraft. It implies that players harvest more gold and their need for RMT is lower and the exchange rate is lower too.*[13]

If we want to establish theoretical background for this hypothesis, we add productivity of ordinary player (Pr) to demand function in supply-demand model in chapter 3 and we assume that demand function is decreasing in productivity (because of the arguments mentioned above). Thus

$$S(P, F, A) - D(ex, Y, Pr) = 0$$

and we use same method as in chapter 3.

$$\frac{dP}{dPr} = -\frac{\frac{\partial Z}{\partial Pr}}{\frac{\partial Z}{\partial P}} = -\left(-\frac{D_{Pr}}{S_P - D_{ex} \cdot \frac{1}{1-\tau}}\right) < 0$$

Thus increase of productivity of ordinary players decreases price of virtual currency and thus the exchange rate decreases too.

We use data between 1.5.2010 and 23.12.2010. We employ AR(3) process[14]. Hence we use following equation

$$\begin{aligned} EXv_{i,t} &= \alpha + \alpha_i + \beta_1 EXv_{i,t-1} + \beta_2 EXv_{i,t-2} + \beta_3 EXv_{i,t-3} + \gamma_1 Patch_{i,t}^{3.3.5} \\ &+ \gamma_2 Patch_{i,t}^{4.0.1} + \gamma_3 Cataclysm_{i,t} + \delta T + \varepsilon_{i,t} \end{aligned}$$

We used fixed effect estimator, because Hausmann test rejected hypothesis that random effect estimator (GLS) is consistent. Let's look on our results.

[13] Author of this hypothesis is Jiri Skuhrovec.

[14] because the trade-off between information criteria and significancy

Variable	Patch 3.3.5 and Cataclysm - fixed effect estimator	
	Coefficient	**P-value**
constant	0,226638	1,53e-039
EXv_1	0,770437	0,0000
EXv_2	0,190066	4,05e-031
EXv_3	-0,0553037	2,27e-05
$Patch^{3.3.5}$	0,0588146	0,0003
$Patch^{4.0.1}$	-0,0329005	0,0456
Cataclysm	-0,126375	2,50e-012
T	9,34383e-05	0,5629

adjusted R^2	**number of observations**
0,872061	5886

There isn't significant time trend. On the other hand we can see that *Cataclysm* and $Patch^{3.3.5}$ are significant as well as as $Patch^{4.0.1}$. Coefficient of $Patch^{3.3.5}$ is positive, thus the patch increased the exchange rate and our hypothesis is proved. Coefficient of the dummy variable *Cataclysm* is lower than zero. It implies that our hypothesis about Cataclysm holds.

Patch 3.3.5 and Cataclysm II - split of *Cataclysm*

In the previous text we showed that Cataclysm caused decrease of the exchange rate. But if we look at the movement of the exchange rate immediately after the release[15], we see that series sharply rose and then sharply fell. Hence we run fixed effect estimator once more in similar form with only one difference - we split *Cataclysm* into two dummy variables. The first of them - *Cataclysm2d* - is **1** two days after Cataclysm was released, otherwise it is **0**. Second dummy variable - *Cataclysm-rest* - is **1** after release of Cataclysm minus two previously mentioned days, **0** otherwise.

[15] In Appendix

Variable	Patch 3.3.5 and Cataclysm - fixed effect estimator	
	Coefficient	**P-value**
constant	0,242784	7,75e-047
EXv_1	0,728523	0,0000
EXv_2	0,204050	5,41e-037
EXv_3	-0,0350158	0,0063
$Patch^{3.3.5}$	0,057469	0,0003
$Patch^{4.0.1}$	-0,0416866	0,0096
Cataclysm2d	0,487340	6,39e-032
Cataclysm-rest	-0,231381	1,19e-034
T	0,000174189	0,2703

adjusted R^2	**number of observations**
0,877712	5886

As we can see,*Cataclysm2d* is positive and statistically significant, thus we are allowed to say that immediately after its release Cataclysm caused increase of the exchange rate, but then the exchange rate fell under initial level. It's hard to interpret this jump. Maybe possible explanation is that part of gold farming companies had technical difficulties with launching Cataclysm and it caused temporary supply shock.

Patch 4.2.0

We chose patch 4.2.0, because it negatively affects skinning[16] - the method of obtaining gold, which is heavily used by gold farmers. It was released on 28th June 2011.

Hypothesis 4 *Worse skinning made (at least for some time) production of gold harder. It implied increase of A, which was following with increase of the exchange rate between dollar and gold.*

[16]Skinning is a profession, we have written about professions in chapter 1, http://www.wowwiki.com/Patch_4.2.0

Now we use AR(4)[17]. Hence our equation has got following form:

$$EXv_{i,t} = \alpha + \alpha_i + \beta_1 EXv_{i,t-1} + \beta_2 EXv_{i,t-2} + \beta_3 EXv_{i,t-3} + \beta_4 EXv_{i,t-4} + \gamma Patch_{i,t}^{4.2.0} + \delta T + \varepsilon_{i,t}$$

We used observation from 45 days before the patch was released and 46 days after the patch was released. Again, we use fixed effect estimator because of the same reason as in the previous case. Let's look at our results. The results are following[18]:

Variable	**Patch 4.2.0 - fixed effect estimator**	
	Coefficient	**P-value**
constant	1,52490	7,42e-033
EXv_1	0,407322	1,24e-080
EXv_2	0,140173	3,97e-010
EXv_3	0,129927	1,57e-08
EXv_4	0,0997104	2,69e-06
$Patch^{4.2.0}$	0,799842	3,42e-014
T	-0,00638094	0,0014

adjusted R^2	**number of observations**
0,664308	2403

Adjusted R^2 is around 66 %. It indicates that the model is good. The results says that contrary to the previous case there is significant decreasing time trend. Moreover, $Patch^{4.2.0}$ is significant and positive, which implies that patch 4.2.0 increases the exchange rate and our hypothesis is proved - patch 4.2.0 increased the exchange rate.

Generally, we can say that all updates, which we examined, affected the exchange rate[19].

[17] again, based on the trade-off criteria and significancy

[18] Gretl was used.

[19] On the other hand there is problem with normality and heteroscedasticity (results of tests are in SIS).

Chapter 6

Conclusion

Aim of this thesis was to describe trading with virtual assets in virtual economies from both perspectives – from point of view of a buyer (player) as well as from point of view of gold farmer himself - with respect to the exchange rate between virtual and real currency. In the microeconomic model with help of implicit function theorem we showed that this exchange rate affects player's time and allocation decision as well as it has got impact on his decision to become a gold farmer. Moreover, there are stated reasons why gold farmers establish companies, especially in China. Then we described firm's organization, its production factors, their costs as well as firm's revenues. With simple supply-demand model of gold farming supply chain we showed that in-game conditions for gold farming (A) affects already mentioned exchange rate – with increase of A exchange rate increases too. Then we stated our hypothesis that one of the sources of its disturbances is operator of MMORPG, which is against RMT and gold farming. With help of game theory model we showed conditions, which are necessary for providing RMT by operator himself – profit from running RMT has to be higher than zero, or loss from RMT providing has to be lower than loss caused by gold farmer's activity. Various sources imply that these conditions are not satisfied, because of ordinary players, who are against providing RMT as well as its tolerating. The operators do not provide RMT, but pursuit gold farmers and use various tools, which are described in the thesis too, especially deleting their accounts and issuing patches. This follows last chapter of the thesis, which tries to discover if second mentioned actions affect the exchange rate. We established simple model of game's upgrading, where variable A is a function of several factors, which are im-

portant (not only) for gold farmers. We extended our supply-demand model from chapter 3 and proposed several in-game changes, which can harm (or benefit) gold farmers. Then we chose the updates in World of Warcraft, which brough these changes. We used panel data econometric methods to examine impact of these updates on the exchange rate. We realized that both patches as well as Cataclysm react according to our assumptions. If we write about updates, we have to mention that in 2012 new World of Warcraft's expansion pack – Mists of Pandaria – will be released by Blizzard an it will be interesting to examine how it affects the exchange rate (if Cataclysm hypothesis will hold in this case too). Impact of the updates are statistically significant and thus we can say that (at least in World of Warcraft) operator's actions have got influence on the exchange rate.

At the end of the thesis we have to state one important question. RMT and gold farming itself are controversial phenomena, which – directly or indirectly – affect millions of people. And it has got potential to affect them positively. If we recall chapters 1 and 2, where we wrote that according Heeks (2008) findings working in gold farming industry is better for unskilled laborers in developing countries than in some of other industries, we can ask a question: can gold farming improves life of more people in developing countries? The answer on this question is not simple. We have to become aware of fact that gold farming is semi-illegal activity from the point of view of law and completely illegal activity from the point of view of EULA. Anyhow, if we take into account this question as well as reasons stated in chapter 1, research of gold farming (and virtual economies overall) is a broad and promising field of economics, where are lots of opportunities for theoretical and empirical economists also because of significant lack of rigorous academical papers.

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Appendix A

MMORPG glossary

1. **Account (WoW)** Account in WoW contains all player's virtual characters and thus all his virtual property. Player pays subscription fee per account, probably majority of ordinary players have only one account. On the other hand, on the account there can be as much virtual characters as player wants.
2. **Add-On** Unofficial modification of a game, which brings new possibilities to it. Key add-on for research of World of Warcraft is **Auctioneer**.

3. **Alliance** One of the two fractions in the World of Warcraft.

4. **Avatar** Another term for player's ingame character, frequently used especially in older literature, in our thesis we use rather the term virtual (or in-game) character.

5. **Ban (of Account)** Utmost measure of operator against player, who violates licence agreement (EULA). Player's account is deleted with all virtual items and characters (without compensation).

6. **Cheating** Doing some immoral or unethical thing with or in the game (definition from http://www.wowwiki.com/Cheating).

7. **Expansion Pack** Official massive additional content, which is distributed by game's operator.

8. **EULA** End User Licence Agreement is an agreement, which describes relationship between the operator and players.

9. **Gold** Currency in several MMORPGs, synonym for virtual currency generally.

10. **Gold Farming** Professional collecting and selling virtual assets, especially currency.

11. **Horde** One of the two fractions in the World of Warcraft.

12. **Level** Indicator, which shows degree of virtual character's power.

13. **MMORPGs** Acronym for Massive Multiplayer Online Role Playing Games, genre of online games, which put stress on development of in-game characters.

14. **NPC** Acronym for non-player character, i.e. characted controlled by artificial intelligence.

15. **Operator (of MMORPG)** Firm, which is responsible for running of a MMORPG and which owns all rights connected with the game.

16. **Patch** Additional program proposed by MMORPG's creator, which corrects errors in the game, alternatively adds new content. Unlike expansion pack it is free.

17. **Power-levelling** A player pays another player to play with his virtual character, it's against EULA.

18. **Quest** Task given to a player character that yields a reward when completed(definition from www.wowwiki.com/quest).

19. **RMT** Acronym for Real Money Trade, which can be defined as use virtual assets to earn real money, or use real currency to obtain ingame assets (money, items, characters,...)

20. **Realm** Realms are called the servers, where World of Warcraft runs. All realms contain the same world. There are lots of realms, because of danger of overpopulation. Some realms are special for certain type of the players, for example realms for role-players, which mentioned in chapter 2. Realms are divided according to WoW geography version. Our dataset contains US realms (version for North and South America) and EU realms (version for Europe).

21. **Spam/spamming** (in WoW) Sending an overly repeated message or large useless quantity of text in a Chat channel (definition from http://www.wowwiki.com/Spam). It can be used for propagation of gold farmers too.

22. **World of Warcraft (WoW)** The most popular MMORPG.

Appendix B

Chapter 5 - graphs and tables

B.1 Development of exchange rate[1]

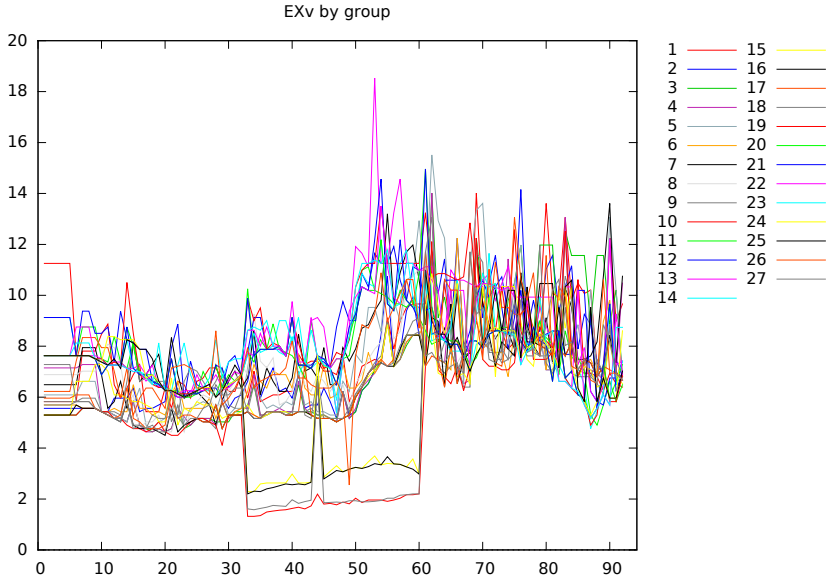

Figure B.1: Exchange rate - patch 4.2.0

[1]Lines in the graphs denote particular realms.

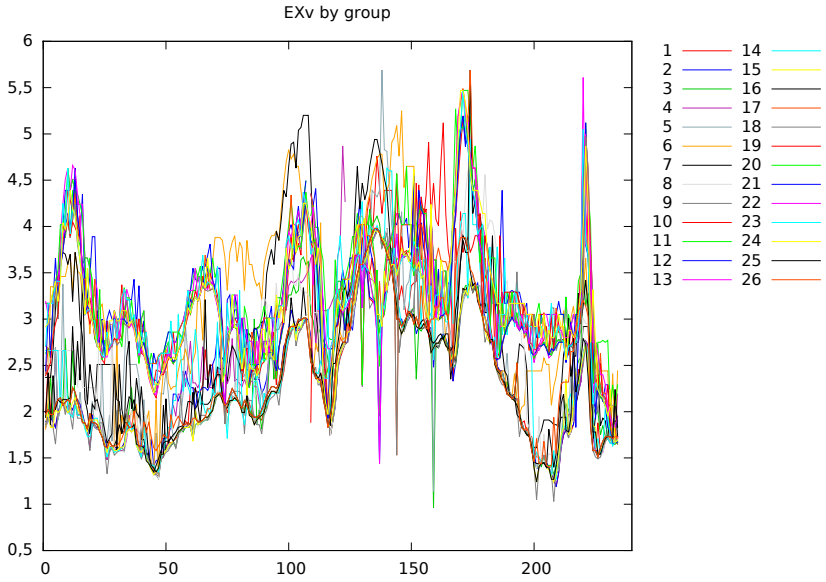

Figure B.2: Exchange rate - patch 3.3.5 and Cataclysm

B.2 Development of exchange rate when the update was issued

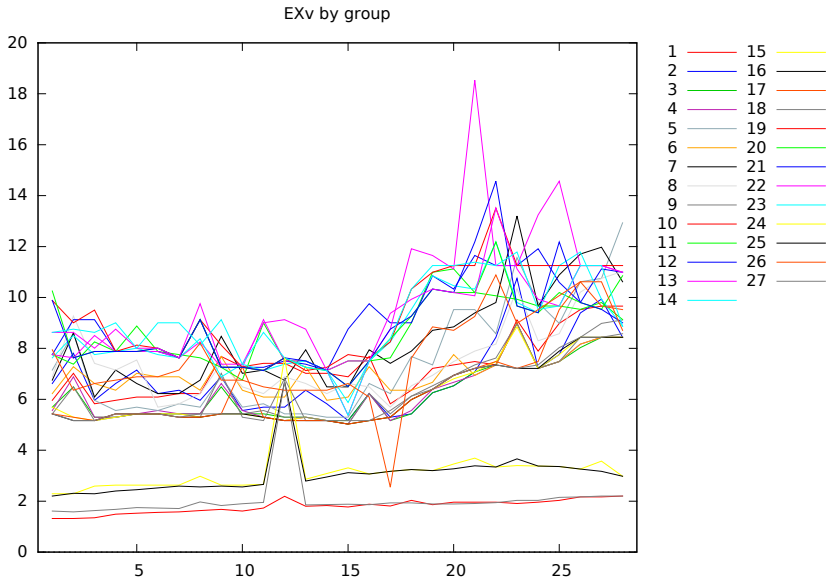

Figure B.3: Exchange rate - patch 4.2.0

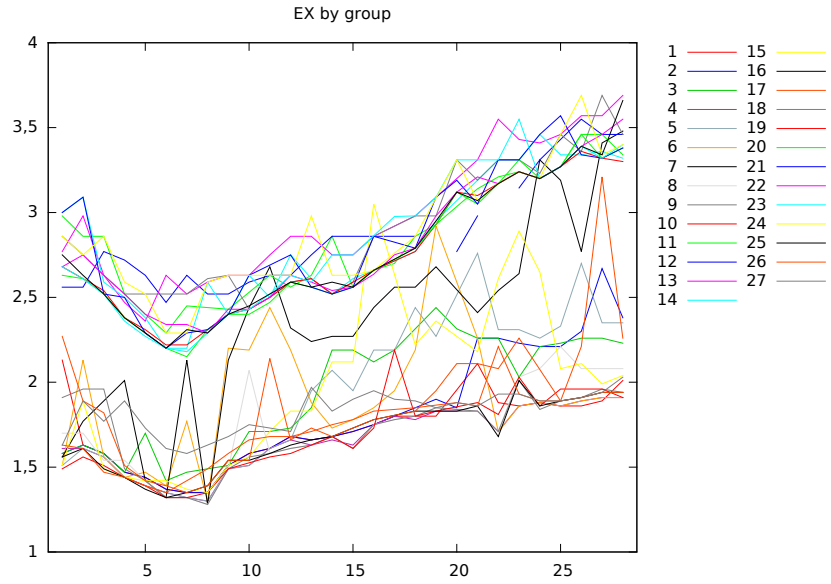

Figure B.4: Exchange rate - patch 3.3.5

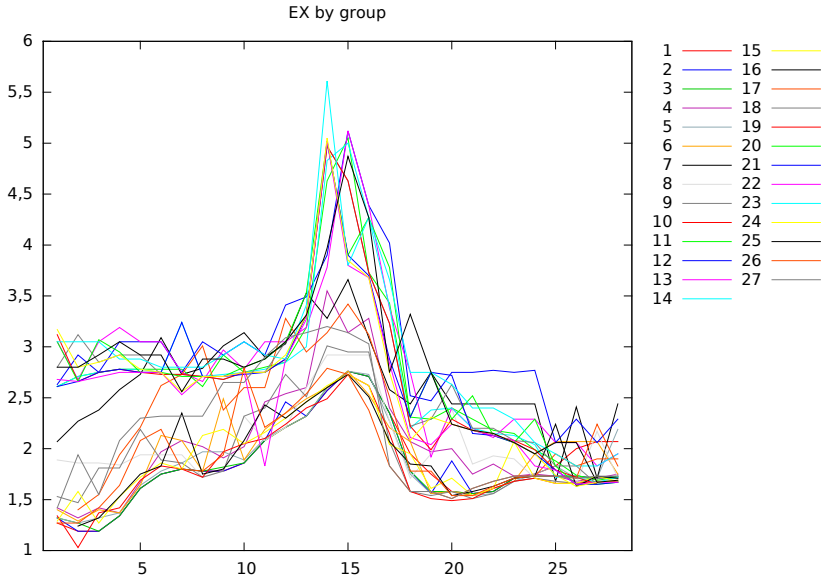

Figure B.5: Exchange rate - Cataclysm

B.3 Table - Criteria

Model	Information Criteria		
	Akaike	**BS**	**HQ**
patch 3.3.5 & Cataclysm I	2263,874	2484,325	2340,504
patch 3.3.5 & Cataclysm II	1998,980	2226,111	2077,932
patch 4.2.0	7780,879	7971,394	7850,224

Appendix C

Mathematical tools

Theorem C.0.1 (Cramer rule)[1]

Let $A \in M(n \times n)$ be regular matrix, $B \in M(n \times 1)$, $B \in M(n \times 1)$ and Ax=b. Then

$$x_j = \frac{\begin{vmatrix} a_{1,1} & \dots & a_{1,j-1} & b_1 & a_{1,j+1} & \dots & a_{1,n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{n,1} & \dots & a_{n,j-1} & b_n & a_{n,j+1} & \dots & a_{n,n} \end{vmatrix}}{\begin{vmatrix} a_{1,1} & \dots & a_{1,j-1} & a_{1,j} & a_{1,j+1} & \dots & a_{1,n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{n,1} & \dots & a_{n,j-1} & a_{n,j} & a_{n,j+1} & \dots & a_{n,n} \end{vmatrix}}$$

for $j = 1, \dots, n$.

Theorem C.0.2 (Silvester's theorem)

Let $A = a_{ij}$, $i = 1, \dots, n$, $j = 1, \dots, n$,$A \in M(n \times n)$ be symmetric. Matrix A is negative semidefinite iff for every $k = 1, \dots, n$ holds

[1] All theorems are from Hajkova et al (2011), except from implicit function theorem(Vinogradov 1999).

$$\text{(-1)}^k \begin{vmatrix} a_{1,1} & \dots & a_{1,n} \\ \vdots & \vdots & \vdots \\ a_{n,1} & \dots & a_{n,n} \end{vmatrix} > 0$$

Theorem C.0.3 (Second order necessary conditions)

Let $G \in G^n$ is nonempty and closed set, $f \in C^2(G)$ and $a \in G$. If f(a) is local maximum, then Hessian is negative semidefinite.

Theorem C.0.4 (Implicit function theorem) *If $F(x, y) \in C^k$ in a set D (i.e. F is k times continuously differentiable at any point in D) and (x_0, y_0) is an interior point of D, $F(x_0, y_0) = c = const$ and $F'(x_0, y_0)$ isn't zero, then the equation $F(x, y) = c$, defines y as a $C^{(k)}$ function of x in some neighbourhood of (x_0, y_0) and*

$$\frac{dy}{dx} = -\frac{F_x}{F_y}$$

UNIVERSITAS CAROLINA PRAGENSIS
založena 1348

Univerzita Karlova v Praze
Fakulta sociálních věd
Institut ekonomických studií

Opletalova 26
110 00 Praha 1
TEL: 222 112 330,305
TEL/FAX: 222 112 304
E-mail: ies@mbox.fsv.cuni.cz
http://ies.fsv.cuni.cz

Akademický rok 2009/2010

TEZE BAKALÁŘSKÉ PRÁCE

Student:	Filip Šmolík
Obor:	Ekonomie
Konzultant:	PhDr. Ing. Jiří Skuhrovec

Garant studijního programu Vám dle zákona č. 111/1998 Sb. o vysokých školách a Studijního a zkušebního řádu UK v Praze určuje následující bakalářskou práci

Předpokládaný název BP:

Virtual Gold Farming

Charakteristika tématu, současný stav poznání, případné zvláštní metody zpracování tématu:

Real money trade is dynamically emerging market inside of massive multiplayer online games, where people exchange real money for virtual goods and currency. Supply side of the market consists of gold farmers – sellers of virtual currency. Most gold farmers live in China and sell it to USA and Europe. The thesis will analyse RMT market. By obtaining data from exchanging servers the changes in price of virtual money will be compared with operator´s policy. Main theme of the work is examination of World of Warcraft farming business. There will be discussed balance sheet of an average Chinese gold farmer – revenues and costs. The thesis will conclude with brief assessment of gold farming potential in development economics.

Struktura BP:

Osnova

1) Introduction to RMT
   - MMORPG
   - RMT
   - gold farming
2) The most significant MMORPG´s, their operators and RMT´s
3) RMT vs operator – on example of World of Warcraft, impact of operator´s actions on RMT

4) Balance sheet of an average Chinese gold farmer
   - experimental estimation of gold farmer´s income
   - fixed and variable costs

5) Application on development economics

Seznam základních pramenů a odborné literatury:

Castronova, E. *Synthetic Worlds*, University of Chicago Press, 2005

Castronova, E. *A Cost-Benefit Analysis of Real-Money Trade in the Products of Synthetic Economies*. Info, Vol. 8, No. 6, October 2006.

Heeks, R. : *Real world production in developing countries for the virtual economies of online games*, Institute for development policy and management, working paper no.32, 2008

Ung-gi Yoon *Real money trading in MMORPG items from a legal perspective,* Journal of Korean Judicature, Vol. 1, pp. 418-477, 2008

http://www.virtualeconomies.net

http://terranova.blogs.com/

Datum zadání:	květen 2010
Termín odevzdání:	květen 2011

Podpisy konzultanta a studenta:

V Praze dne